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NASA Project Apollo Working Paper No. 1085A

PROJECT APOLLO FLIGHT MISSION DIRECTIVE
FOR FIRST SATURN/APOLLO LAUNCH EXIT ENVIRONMENT

APOLLO MISSION A-101

(BP-13)

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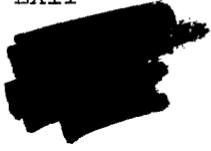
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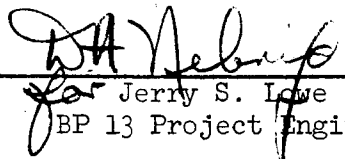
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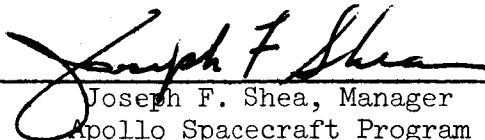

NASA PROJECT APOLLO WORKING PAPER NO. 1085A

PROJECT APOLLO FLIGHT MISSION
DIRECTIVE FOR FIRST SATURN/APOLLO LAUNCH EXIT
ENVIRONMENT APOLLO MISSION A-101 

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FOREWORD

This document provides the payload overall requirements for the first Apollo test on the Saturn I launch vehicle, which is to be launched from Launch Complex 37B at Kennedy Space Center, Florida. This mission is Apollo Mission A-101 and the payload will be the Apollo Spacecraft Boilerplate No. 13 (BP-13) command and service module and adapter. All payload detailed planning for this test shall be consistent with this document. The Saturn I launch vehicle, designated SA-6, will be the second of the two stage Saturn I, consisting of an S-I first stage and S-IV second stage, to be launched. The S-IV and the Apollo configuration will be inserted into a 100 nautical mile circular orbit. The principle mission objectives with regard to the Spacecraft includes measurement of launch environment parameters and demonstration of the compatibility of the launch configuration.

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TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1-1
	1.1 Purpose	1-1
	1.2 Scope	1-1
	1.3 Precedence of Reports	1-1
	1.4 Amendments	1-1
	1.5 Definition of Objectives	1-2
	1.6 Definition of Subsystem Priorities	1-2
	1.7 Definitions of Objective Terminology	1-3
2.0	TEST OBJECTIVES AND SYSTEM PRIORITIES	2-1
	2.1 General	2-1
	2.2 Test Objectives	2-1
	2.3 Subsystem Priorities	2-1
3.0	MISSION DESCRIPTION	3-1
	3.1 General Flight Plan	3-1
	3.2 Sequence of Events and Flight Parameters	3-1
	3.3 Trajectories	3-2
	3.4 Flight Constraints	3-2
4.0	DESCRIPTION OF BOILERPLATE 13 TEST VEHICLES	4-1
	4.1 Spacecraft Weight and Balance Summary	4-1
	4.2 Launch Escape Subsystem	4-2
	4.3 Command Module	4-3
	4.4 Service Module plus insert	4-5
	4.5 Boilerplate Adapter	4-6
5.0	STRUCTURAL DESIGN CRITERIA	5-1
	5.1 General	5-1
6.0	AERODYNAMIC STABILITY	6-1
	6.1 General	6-1
7.0	INSTRUMENTATION REQUIREMENTS	7-1
	7.1 General	7-1
	7.2 Onboard Instrumentation	7-2

UNCLASSIFIED

Section		Page
	7.3 Data Acquisition Systems	7-2
	7.4 Measurement Requirement List Nomenclature . .	7-3
	7.5 Electrical Umbilical Functions	7-6
	7.6 Changes	7-6
8.0	TRACKING AND SUPPORT DATA REQUIREMENTS	8-1
	8.1 General	8-1
	8.2 Metric Trajectory Data	8-1
	8.3 Photographic Data	8-1
	8.4 Timing	8-2
	8.5 Meteorological Data	8-2
	8.6 Data Disposition	8-2
9.0	PRELAUNCH OPERATION	9-1
	9.1 Test Preparation - NAA, Downey	9-1
	9.2 AMR Operations	9-5
	9.3 Countdown Activities	9-12
10.0	TEST MANAGEMENT ORGANIZATION	10-1
	10.1 General.	10-1
11.0	RECOVERY REQUIREMENTS	11-1
	11.1 General	11-1
12.0	LAUNCH DAY REQUIREMENTS	12-1
	12.1 Weather Requirements for Launch	12-1
13.0	PAD AND RANGE SAFETY REQUIREMENTS	13-1
	13.1 Pad Safety	13-1
	13.2 Range Safety	13-1
14.0	DATA HANDLING, ANALYSIS AND REPORTING	14-1
	14.1 Data Handling	14-1
	14.2 Mission Analysis and Reporting	14-2
15.0	GROUND SUPPORT EQUIPMENT	15-1
	15.1 General	15-1
	15.2 Ground Support Equipment	15-1
16.0	REFERENCES	16-1

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
3-1	Launch Configuration	3-5
3-2	Sketch of Boilerplate 13	3-6
3-3	Flight Profile	3-7
3-4	Earth Track for One Orbit	3-8
3-5	Time History of Load Factor, Dynamic Pressure and Pitch Attitude	3-9
3-6	Time History of Velocity, Attitude and Flight- path Angle	3-10
4-1	Environmental Control Subsystem	4-7
4-2	Electrical Power Subsystem	4-8
4-3	Sequencer Functional Diagram	4-9
6-1	Coefficient at Zero Lift with Power On for Launch Configuration	6-2
6-2	Normal Force and Side Force Derivatives for Launch Configuration	6-3
6-3	Pitching Moment and Yawing Moment Derivatives for Launch Configuration	6-4
7-1	R&D Instrumentation and Communications System . .	7-25
7-2	Spacecraft Measurement Locations	
	(a) Accelerometers, Vibration Transducers, and Strain Gauges	7-26
	(b) Calorimeter and Calorimeter Body Temperatures	7-27
	(c) Fluctuating Pressure Measurements	7-28
	(d) Command Module Static Pressure Locations . .	7-29
	(e) LES Tower Temperature Locations	7-30

<u>Figure</u>		<u>Page</u>
7-3	Reference Axis System	7-31
9-1	Sequence of Test Operations	9-15

LIST OF TABLES

Table		Page
3-2	Sequence of Events and Flight Parameters.....	3-2
4-1	Spacecraft Weight & Balance.....	4-1
7-1	Apollo Boilerplate Measurement List.....	7-7
7-2	Electrical Umbilical Functions.....	7-18

LIST OF ABBREVIATIONS

The following list includes all abbreviations used throughout this document.

γ	Flight Path Angle (Degrees)
AC	Alternating Current
Accel.	Accelerometer
ADP	Adapter
AFMTC	Air Force Missile Test Center
Amp	Amplifier
Amps	Amperes
AMR	Atlantic Missile Range
ASPO	Apollo Spacecraft Program Office
ATR	Apollo Test Requirements
B/F/S	British Thermal Unit per Square Foot per Second
BP;B/P	Boilerplate Spacecraft
Calib.	Calibration
Calmtr.	Calorimeter
C_{D_0}	Coefficient of Drag at Zero Lift
C.G.	Center of Gravity
C_m	Rate of Change of Pitching-Moment Coefficient, C_m , with Angle of attack, α
CM;C/M	Command Module
C_N	Rate of Change of Normal-Force Coefficient, C_N , with Angle of attack α

$C_{n\beta}$	Rate of Change of Yawing Moment Coefficient, C_n , with Angle of Sideslip β
C/O	Checkout
$C_{y\beta}$	Rate of Change of Side-Force Coefficient, C_y , with Angle of Sideslip β
CPS	Cycles per Second
DB	Decibel
DC	Direct Current
Deg. C	Degrees Centigrade
Deg. F	Degrees Fahrenheit
ECS	Environmental Control Subsystem
EMI	Electromagnetic Interference
EPS	Electrical Power Subsystem
ET	Escape Tower
G	Gravitational Constant
GFP	Government Furnished Property
GSE	Ground Support Equipment
h	Altitude (feet)
Hr.	Hour
I.U.	Instrument Unit of Saturn Vehicle
I_x	Moment of Inertia Along X Axis
I_y	Moment of Inertia Along Y Axis
I_z	Moment of Inertia Along Z Axis

Jett.	Jettison
L _{ref}	Reference Moment ARM
LES	Launch Escape Subsystem
LSC	Linear Shaped Charge
L/V	Launch Vehicle
Mc	Megacycle
Min.	Minutes
MSC	Manned Spacecraft Center
MSFC	Marshall Space Flight Center
η_x	Load Factor Along X Axis
NAA-S&ID	North American Aviation, Inc. Space and Information Systems Division
NASA	National Aeronautics and Space Administration
θ	Body Attitude Angle (Degree)
OAT	Overall Test
OTP	Operational Test Procedure
PIA	Pre-installation Acceptance
Press	Pressure
PSIA	Pounds per Square Inch Absolute
PSIG	Pounds per Square Inch Gage
Pwr	Power
Pyro	Pyrotechnic
q	Dynamic Pressure (Pounds/feet ²)
R&D	Research and Development
RCS	Reaction Control Subsystem
RF	Radio Frequency

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RF Amp	Radio Frequency Amplifier
Ref.	Reference
RFI	Radio Frequency Interference
S.A.D.	Special Adaptive Device
S _{ref}	Reference Area (Square feet)
SC:S/C;Spert.	Spacecraft
SCO	Subcarrier Oscillator
Sec.	Second
Seq.	Sequence
Sig. Cond.	Signal Conditioner
SM;S/M	Service Module
SMD	Special Measuring Device
S-I	Saturn Launch Vehicle First Stage
S-IV	Saturn Launch Vehicle Second Stage
S/S	Samples per Second
Temp.	Temperature
TM;T/M	Telemetry
Twr.	Tower
UI/In	Micro inch per inch
V	Velocity
VAC	Volts Alternating Current
VDC	Volts Direct Current

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VHF	Very High Frequency
Vib.	Vibration
VSWR	Voltage Standing Wave Ratio
Xmtr.	Transmitter
X _a	X Axis Location on Overall Spacecraft
X _A	X Axis Location on Adapter
X _C	X Axis Location on Command Module
X _L	X Axis Location on Launch Escape Subsystem
X _S	X Axis Location on Service Module
α	Angle of Attack
β	Angle of sideslip.

1.0 INTRODUCTION

1.1 Purpose.-

This Flight Mission Directive shall be the official NASA instrument governing the conduct of the first Apollo test on the Saturn I launch vehicle. This test will be performed to investigate the launch environment. The primary spacecraft objective will be to determine the launch and exit environmental parameters. The S-IV launch vehicle and spacecraft will be placed into a 100 nautical mile circular orbit with no recovery planned. This mission is designated Apollo Mission A-101.

1.2 Scope.-

The specific purpose of the Flight Mission Directive is as follows:

To specify test objectives, describe vehicle configuration and system priorities, describe flight trajectories, data and instrumentation requirements for Boilerplate 13 testing.

To provide information required by the AMR for planning the subject flight. The detailed range facilities requirements, logistics support requirements and range contractor requirements are beyond the scope of this report and are contained in the Operations Requirements No. 2400 for Boilerplate 13. (Ref. 3)

1.3 Precedence of Report.-

The Flight Mission Directive supplements the NASA Apollo Program General Test Plan and shall take precedence over all other documents concerning this flight with respect to the payload (S/C).

1.4 Amendments.-

This document will be revised as necessary to reflect changes in the test plan and provide information that is not available at this time. Any proposed revisions shall not be incorporated

into the detailed test plans until incorporated in this document. Published copies of these revisions will be distributed to all contractors and applicable agencies.

1.5 Definition of Objectives.-

The objectives for this test are described as being Apollo Spacecraft First-Order or Apollo Spacecraft Second-Order. These categories are defined as follows:

1.5.1 Apollo Spacecraft First-Order Test Objectives.-

These test objectives define the main reason for making the flight and must be achieved for the flight to be a success. Malfunction of spacecraft systems, ground support equipment, or instrumentation which jeopardize the attainment of first-order objectives will be cause to hold or scrub the flight until such time as a fix can be made.

1.5.2 Apollo Spacecraft Second-Order Test Objectives.-

Second-Order test objectives are those desired to support future Apollo flights or to supply supplementary data for overall spacecraft evaluation. Malfunctions of spacecraft subsystems, ground support equipment or instrumentation which jeopardize the attainment of second-order objectives will not require a hold after start of countdown. Correction thereafter may be made at the discretion of the NASA Test Conductor.

1.6 Definition of Subsystems Priorities.-

The spacecraft subsystems are assigned either primary or secondary priorities. During the initial test program, when incomplete subsystems are tested, this definition will apply to the component level.

1.6.1 Primary Subsystems.-

Primary subsystems are those functionally required for the spacecraft to perform its planned mission. A hold or scrub will be mandatory if any of these subsystems indicate improper performance prior to launch. Positive indication of satisfactory performance must be available.

1.6.2 Secondary Subsystems.-

Secondary subsystems are those not functionally required for the spacecraft to perform its planned mission. Malfunction of any of these subsystems may or may not cause a flight countdown hold or scrub, as dictated by the order of the objectives which they support.

1.7 Definition of Objective Terminology.-

The definition of terms used in connection with objectives for the directive are as follows:

1.7.1 Demonstrate.-

Denotes the occurrence of an action or an event during a test. The accomplishment of an objective of this type requires a qualitative answer. The answer will be derived through the relation of this action or event to some other known information or occurrence. This category of objective implies a minimum of airborne instrumentation, and/or that the information be obtained external to the spacecraft.

1.7.2 Determine.-

Denotes the measurement of performance of any subsystem or component. This category implies a quantitative investigation of overall operation which includes, generally, instrumentation for measuring basic inputs and outputs of the system. The information obtained should indicate to what extent the subsystem is operating as designed. The instrumentation should allow performance deficiencies to be isolated to either the subsystem or to the subsystem inputs.

1.7.3 Evaluate.-

Denotes the measurement of performance of any subsystem or component as well as the performance and/or interaction of its parts that are under investigation. The accomplishment of objectives of this type requires quantitative data on the performance of the subsystem or components. The performance levels will then be analyzed for their contribution toward performance of the subsystem. This category will provide the most detailed information of any of these categories.

1.7.4 Obtain Data.-

Denotes gathering engineering information which is to be measured to augment the general knowledge required in the development of the overall spacecraft. This category may also be used for supplemental investigation such as environmental studies, ground equipment studies, etc. The degree of instrumentation is not implied by this definition.

1.7.5 Establish.-

Denotes gathering engineering information for the development of ground procedures and operating techniques. Objectives in this category are not necessarily dependent on analytic studies.

2.0 TEST OBJECTIVES AND SYSTEM PRIORITIES

2.1 General.-

The purpose of Apollo Mission A-101 is to determine, in addition to the launch vehicle objectives, the launch and exit environment on the spacecraft, referred to herein as Apollo Boilerplate 13.

2.2 Test Objectives.-

2.2.1 First-Order Test Objectives for Spacecraft.-

2.2.1.1 Demonstrate the physical compatibility of launch vehicle and spacecraft under preflight and flight conditions.

2.2.1.2 Determine the launch and exit environmental parameters to verify design criteria.

2.2.1.3 Demonstrate the primary mode of the launch escape tower jettison using the escape tower jettison motor.

2.2.2 Second-Order Test Objectives for Spacecraft.-

2.2.2.1 Demonstrate the structural integrity of the Launch Escape subsystem under flight loading conditions.

2.2.2.2 Demonstrate the compatibility of the R&D communications and instrumentation subsystem with the launch vehicle subsystems.

2.2.2.3 Demonstrate compatibility of GSE handling equipment and procedures.

2.3 System Priorities.-

2.3.1 Launch Escape Subsystem.-

Jettison Motor	P
Escape Tower Separation Subsystem	P

2.3.2 Electrical Power Subsystem.-

Battery Power Subsystem	P
Partial LES Sequencer	P

2.3.3 Communications and Instrumentation Subsystem.-

Telemeter and Antenna Subsystem	P
Radar Beacons	S
Instrumentation	*

2.3.4 Environmental Control Subsystem.-

Temperature Control	S
---------------------	---

P - Primary

S - Secondary

* - Parameter priorities are listed in Table 7-1

3.0 MISSION DISCRIPTION

3.1 General Flight Plan.-

The Saturn/Apollo vehicle will be launched from Complex 37B with the vehicle pitch plane at an azimuth of 90 degrees true and with a programmed roll to a flight azimuth of 105 degrees true, prior to the start of the pitch maneuver. The Saturn I launch vehicle, designated SA-6, will be the second launch of the two stage Saturn I configuration. It will consist of the S-I first stage, S-IV second stage, and the Instrumentation Unit (IU). The flight configuration is shown in Figures 3-1 and 3-2. Figure 3-3 shows a preliminary flight profile from launch to orbit injection indicating major events during the flight. No separation of the spacecraft from the launch vehicle is planned. The S-IV and the Apollo Boilerplate 13 configuration will be inserted into a 100 nautical mile circular orbit. The telemetry subsystems will remain operating in orbit, although no orbital data are required. No recovery is planned. The trajectory requirements are to be determined by Marshall Space Flight Center.

3.2 Sequence of Events and Flight Parameters.-

The sequence of events and flight parameters from S-1 ignition through orbit injection and S-IV cutoff are presented in Table 3-2.

3.3 Trajectories.-

For expediency, trajectories calculated by NAA-S&ID are presented herein; however, final Saturn I trajectories will be determined by the NASA Marshall Space Flight Center. Trajectory parameters are presented as follows:

Figure 3-4 Earth track for one orbit.

Figure 3-5 Time history of load factor, dynamic pressure, and pitch attitude.

Figure 3-6 Time history of velocity, altitude, and flight path angle.

3.4 Flight Constraints.-

Flight constraints define the minimum mandatory qualification tests which must be completed on each major vehicle subsystem prior to launch. An unsatisfied flight constraint may cause a flight hold.

- 3.4.1 The R&D Instrumentation and Electrical Power Subsystem will be qualified by a minimum of one previous flight test. In the event of a subsystem failure on the last flight test prior to BP-13 flight, any design change or system fix will be completely ground demonstrated.
- 3.4.2 The tower jettison motor will be qualified by a minimum of three firings of flight configuration motors using hot wire initiators. No unexplained deviations from the specification values will be acceptable. The Boilerplate 12 constraint testing will satisfy this constraint.
- 3.4.3 The launch escape tower will be qualified by the completion of load testing per ATR-500 (Ref. 7).
- 3.4.4 The launch escape tower release subsystem will be satisfied by the completion of separation tests per ATR-102B (Ref. 8).

- 3.4.5 The launch escape subsystem tower sequencer will be qualified by satisfactory completion of the minimum air worthiness tests per specification MA0205-0014 (Ref. 9).
- 3.4.6 The launch escape subsystem sequencer will be qualified by satisfactory completion of the minimum air worthiness tests per specification MA0405-0002 (Ref. 10) and the sequencer subsystem breadboard tests per ATR-2547 (Ref. 11).

Table 3.2 Preliminary Sequence of Events and Flight Parameters

Time Sec	Event	Velocity Ft/Sec	Altitude Ft	Dyn. Press., lb/ft ²	Flt. Range Path N.M. Angle, deg	Mach No.
T - 0	S-I Ignition	0	0	0	-	0
T + 3.42	Liftoff	-	-	-	90	-
T + 74.42	Max q	1595	41,292	710	53	- 1.65
T + 143.95	S-I Inbd. Eng. Cut-off	-	197,502	22.4	-	-
T + 150.92	S-I Cut-off	8741	222,409	10.0	24	50 8.98
T + 153.62	S-IV Ignition	8707	232,043	6.64	24	55 9.22
T + 163.62	Tower Jettison	8800	266,300	0	21.9	67 -
T + 433.44	Peak Altitude	14,763	657,542	-	0	545 -
T + 617.95	Orbit Insertion	24,202	607,612	-	0	1101 -

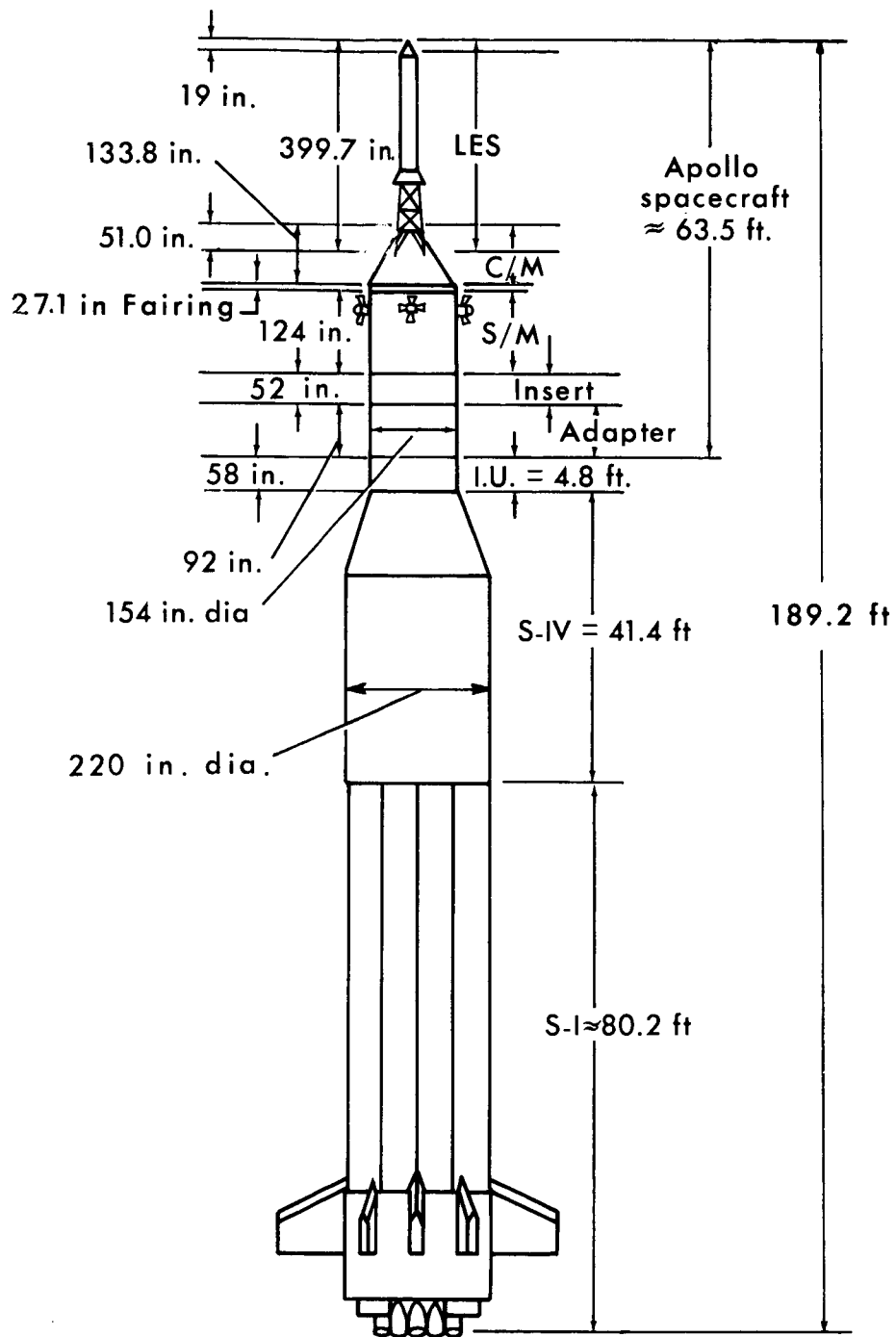


Figure 3-1 - Launch configuration

3-6

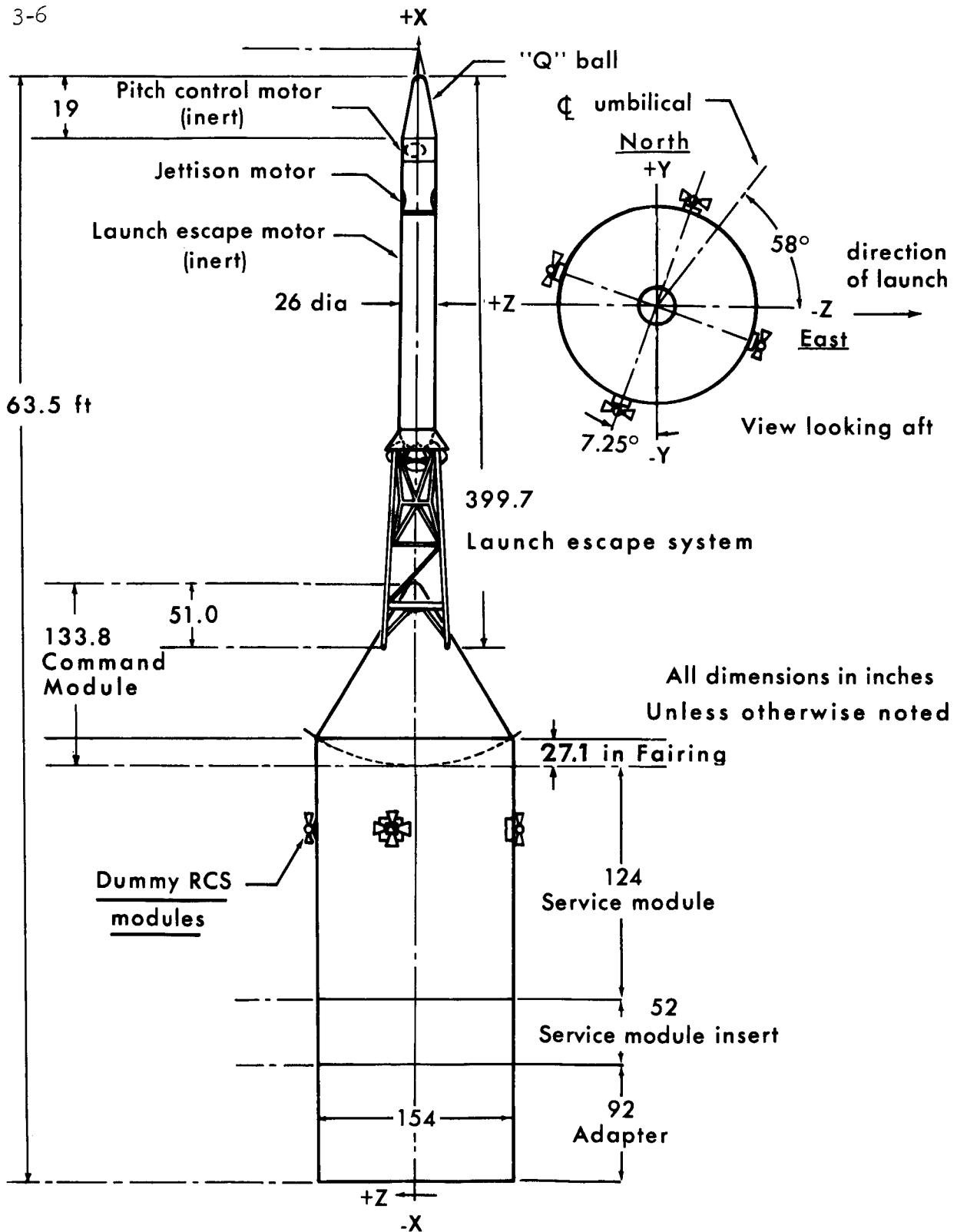


Figure 3-2 - Sketch of boilerplate 13

Flight sequence:

1. Space vehicle launch
2. S-I burnout and separation
3. S-IV ignition
4. LES tower jettison
5. Injection into orbit at S-IV burnout

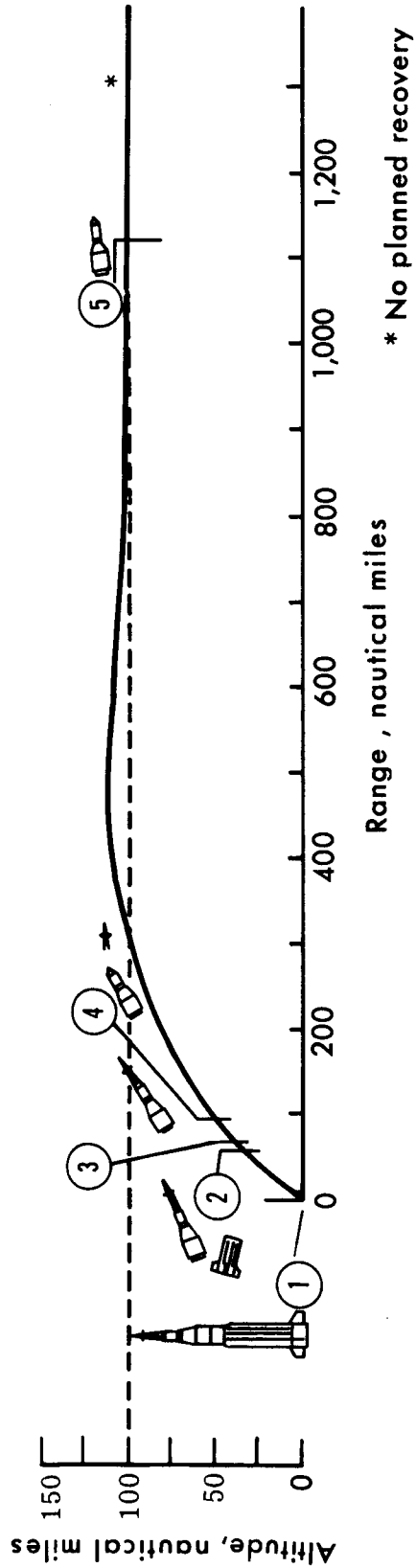


Figure 3-3 - Flight profile

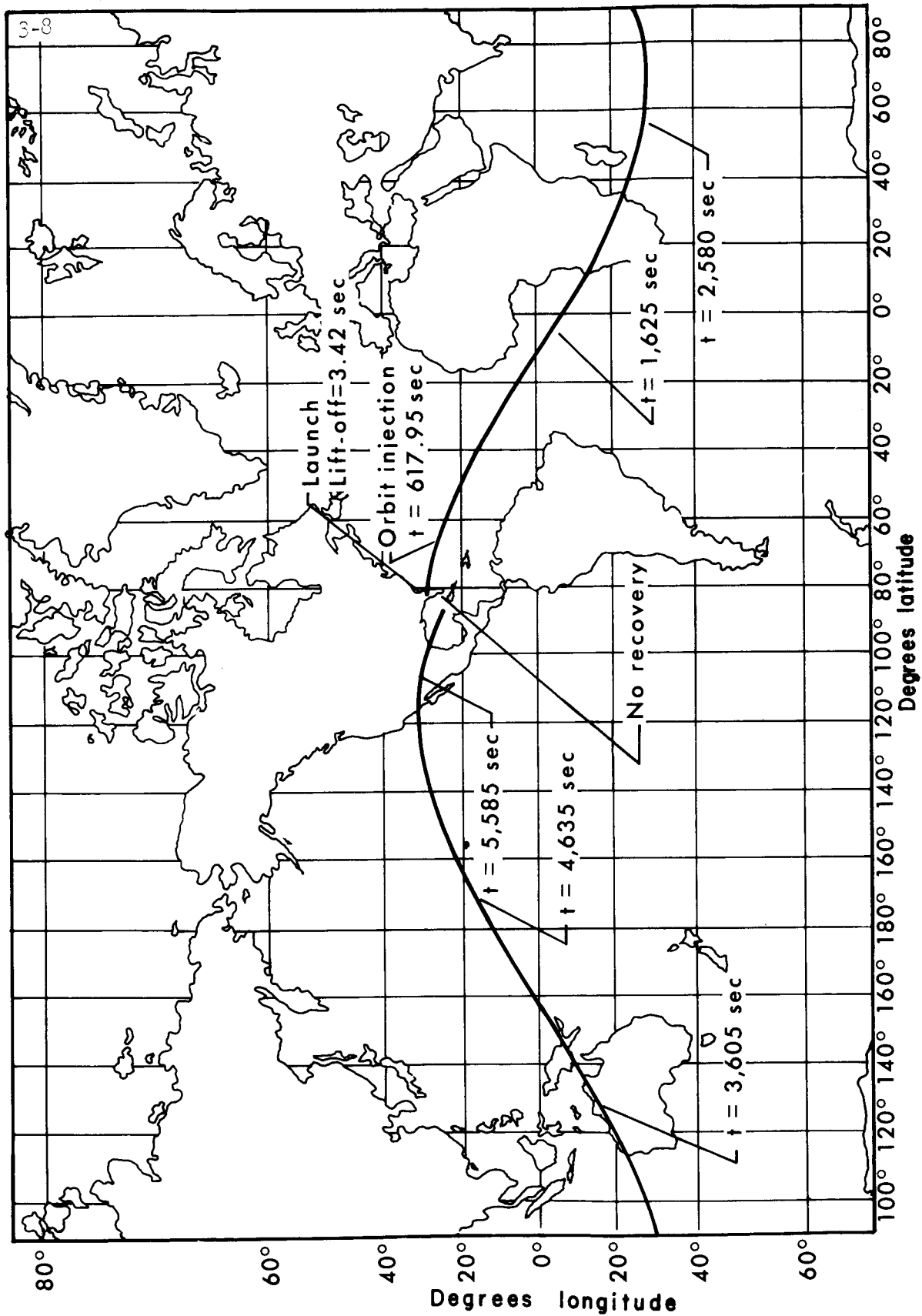
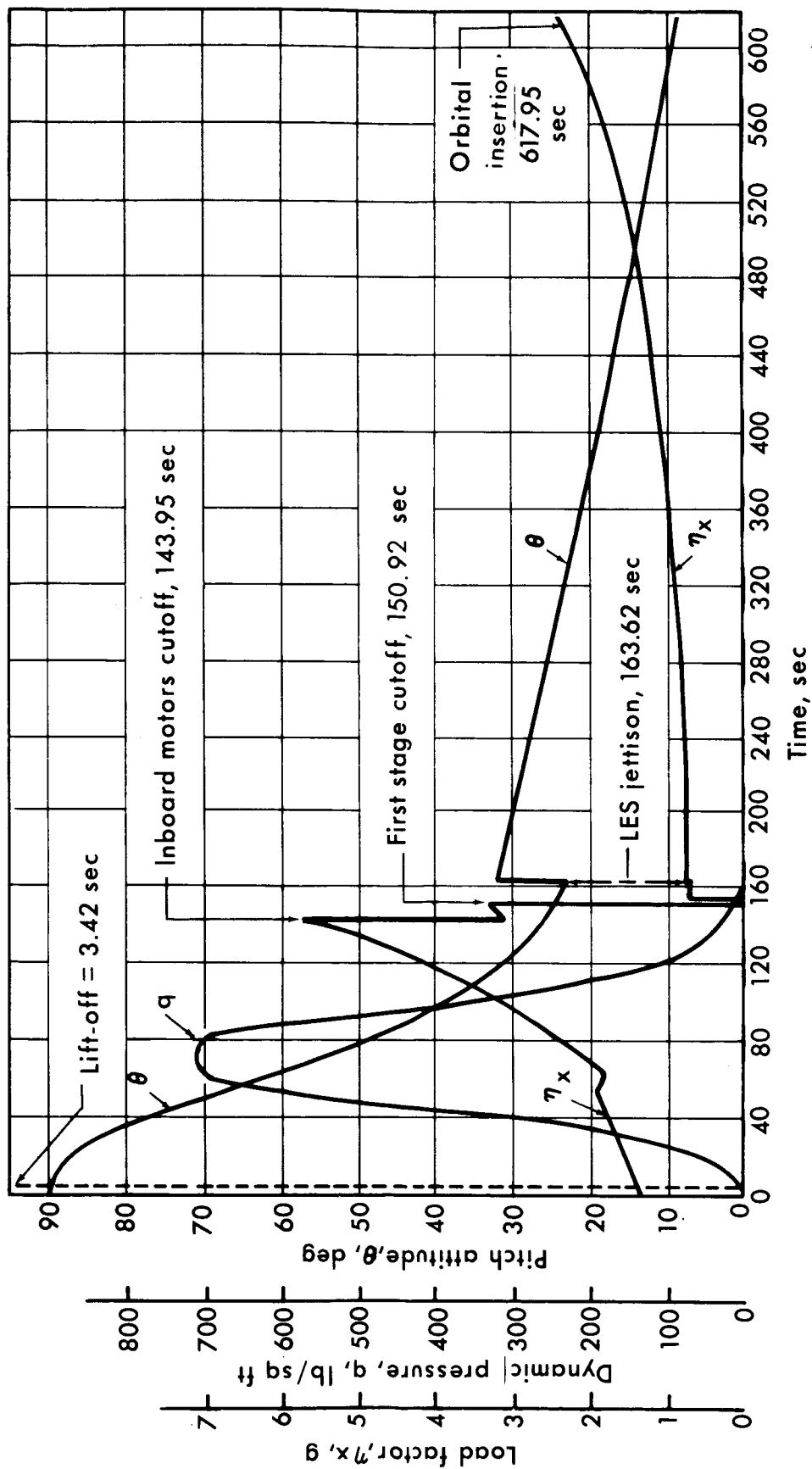


Figure 3-4 - Earth track for one orbit



3-9

Figure 3-5 - Time history of load factor, dynamic pressure, and pitch attitude

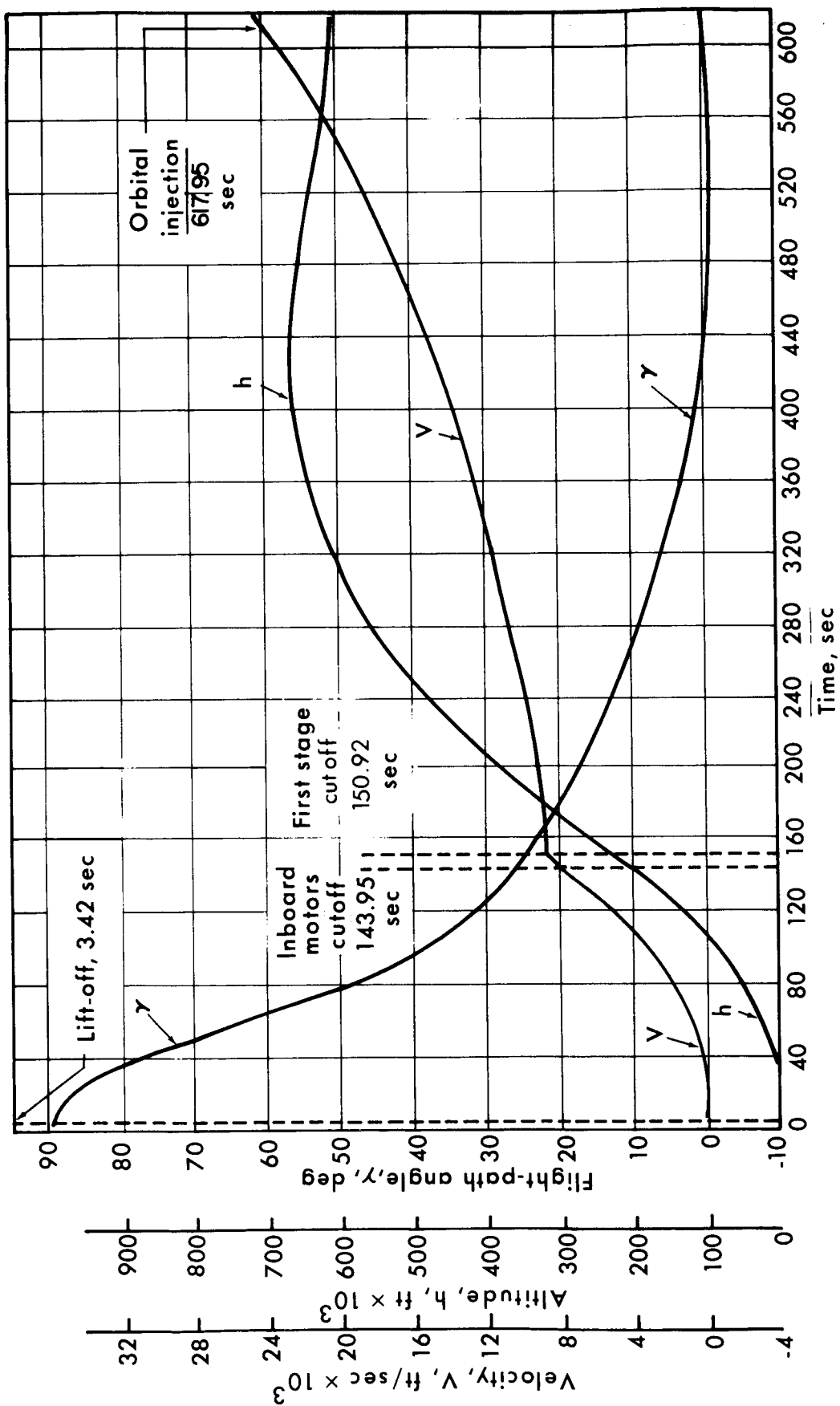


Figure 3-6 - Time history of velocity, altitude, and flight-path angle

4.0 DESCRIPTION OF BOILERPLATE 13 TEST VEHICLE

Table 4.1 Spacecraft Weight and Balance. -
(See Figure 7-3 for axis system.)

	Weight, lb	C.G. Per Axis			Moment of inertia, (Slug-Ft ²)		
		Xa	Ya	Za	Ix Roll	Iy Pitch	Iz Yaw
Command Module	9266	1041.2	2.4	5.2	5626	4059	3996
Service Module	4155	950.9	1.3	-0.5	4999	4170	4154
Insert/Adapter	3519	785.8	-3.2	-1.5	4348	3717	3738
In-Orbit Payload	16990	966.0	1.0	2.4	15025	48138	48059
LES	6597	1293.7	0	-0.2	255	9260	9262
Lift-Off Payload	23537	1057.8	0.7	1.7	15288	167548	167465

4.2 Launch Escape Subsystem.-

The launch escape subsystem consists of an inert pitch control motor, live tower jettison motor, inert launch escape motor, and nozzle skirt, spacecraft escape tower with separation mechanism, and necessary instrumentation sensors and wiring. Mounted within the nose cone is a Q-Ball .

4.2.1 Q-Ball .-

The Q-Ball is a dynamic pressure sensor for measuring angle of attack for use in trajectory analysis for launch vehicle guidance subsystem evaluation. The weight is approximately 23 pounds.

4.2.2 Pitch Control Motor.-

Boilerplate 13 uses a simulated pitch control motor which is 9 inches in diameter, 22 inches long and weighs 35 pounds.

4.2.3 Tower Jettison Motor.-

The tower jettison motor is a solid propellant reaction motor, 26 inches in diameter and 47 inches in length, with a bolt flange of the aft end for attachment to the forward end of the launch escape motor. The motor contains two thrust nozzles positioned 30° from the motor centerline. The resultant thrust centerline is located $2.5^{\circ} \pm 0.5^{\circ}$ from the motor centerline. The gross weight of the motor is 550 pounds, which includes the interstage structures. The motor develops 33,000 pounds of thrust for one second, with burnout occurring at approximately 1.3 seconds. The theoretical thrust time curve for the tower jettison motor is presented in reference 1.

4.2.4 Launch Escape Motor.-

Boilerplate 13 uses a simulated launch escape motor which weighs approximately 4900 pounds, is 26 inches in diameter and 183 inches long.

4.2.5 Tower Structure.-

The boilerplate 13 launch escape tower is of production configuration, is a welded tubular titanium alloy, and is a truncated rectangular structure with a rectangular cross-section. The tower is approximately 120 inches long with a base 46 inches by 50 inches. The tower forms the intermediate structure between the command module and the escape motor. A structural skirt is used to attach the escape motor to the tower. The tower structure is covered with ablative material, buna-N rubber 60% silica filled.

4.2.6 Tower Release Mechanism.-

The launch escape tower separation subsystem consists of four explosive bolts. Each bolt contains a single explosive charge and incorporates a dual ignition feature to increase reliability. Positive release is assured when either one or both of the hot wire initiators are fired. In normal operation both hot wire initiators will be fired.

4.3 Command Module.-

The Command Module is a boilerplate structure simulating the size and shape of the manned operational spacecraft. It is semi-monocoque type aluminum structure containing provisions for separation of the launch escape tower. The Command Module is covered externally with cork insulation material to protect the aluminum structure against overheating. External protuberances of the manned spacecraft configuration, such as the scimitar antennas and the CM air vent, are simulated on BP-13 for a better definition of aerodynamic parameters.

4.3.1 Crew Compartment.-

The boilerplate compartment uses the frame stiffeners of the exterior shell structure to attach mountings for instrumentation, electrical power subsystem, any ballast required, and internal insulation against aerodynamic heating of the structure. Also included are a main hatch (aluminum alloy structure) bolted to the CM structure for access to the compartment shell and a forward access way (tabular structure of aluminum) welded to the forward bulkhead. The forward access way is provided with a bolted-on cover.

4.3.2 Aft Heat Shield.-

The boilerplate aft heat shield is similar in shape to the operational heat shield. It is composed of an inner and outer layer of laminated glass over an aluminum honeycomb core and is attached to the CM by four adjustable struts.

4.3.3 Forward Compartment Cover.-

The forward compartment cover consists of a sheet metal fabricated cover and a fiberglass honeycomb radome assembled together. The assembly is bolted to the CM.

4.3.4 Communications and Instrumentation Subsystem.-

The boilerplate communications and instrumentation equipment are listed in Section 7. This subsystem will remain on until the battery power is expended during the flight test.

4.3.5 Environmental Control Subsystem.-

Boilerplate l3 cooling subsystem (See Figure 4-1) provides cool air in a continuous flow to maintain the CM ambient temperature at a level less than 75° F while on the ground. Cooling is supplied to the transponders and telemetry transmitters through a cold plate mount. The thermal capacity is stored in the form of water/glycol, cooled by ground support equipment and supplied through an umbilical. Subsequent to umbilical disconnect, there is approximately 1.5 hours of flight cooling capacity

(also useable for pad "holds"). The fan will continue to run after umbilical disconnect until the CM interior pressure reaches an equivalent altitude of 25,000 feet. The pump runs as long as power is available. Power is supplied from the Electrical Power Subsystem (See Figure 4-2) after power switch-over to internal. Prior to this power is ground supplied.

4.3.6 Electrical Power Subsystem.-

The boilerplate electrical power subsystem, shown in Figure 4-2, consists of two instrumentation batteries, two pyro batteries, two logic batteries, power control box, and junction box. The instrumentation batteries are 120 ampere-hour units, the pyro and logic batteries are 5 ampere-hour units.

4.3.7 Launch Escape System Sequencer.-

The sequencer for BP-13 does not initiate any mission sequence functions, but serves primarily as the arm/de-arm mechanism for the pyrotechnic devices. The tower separation and jettison motor firing signal is being provided by the Saturn Instrument Unit flight sequencer to the LES sequencer. The LES sequencer forwards this signal to the tower sequencer firing circuits. The sequencer includes two independent and identical sections that perform identical functions. Each section contains separate pyro and logic batteries and busses, and individual pyro and logic arm/de-arm motor switches. The sequencer functional diagram, Figure 4-3, is not the final configuration for the sequencer. The sequencer will be modified and details of the modifications are not available for inclusion at this time.

4.4 Service Module Plus Insert.-

The boilerplate service module and insert are semi-monocoque type aluminum structures 15¹/₄ inches in diameter. The service module and insert are 12¹/₄ inches and 52 inches in length, respectively, and are bolted together. The service module is attached to the command module by an inert or non-functioning separation system. The insert is bolted to the adapter. An active umbilical system, instrumentation sensors, and associated cabling are contained in the service module. Also included are

dummy Reaction Control Subsystem (RCS) quadrant packages having the same size, shape, location, and aerodynamic characteristics as live SM RCS packages.

4.5 Boilerplate Adapter.-

The boilerplate adapter is a semi-monocoque type aluminum structure attached to the Instrument Unit with bolts. The adapter is 154 inches in diameter, 92 inches in length, and contains an air conditioning barrier as well as instrumentation sensors and associated cabling and ballast.

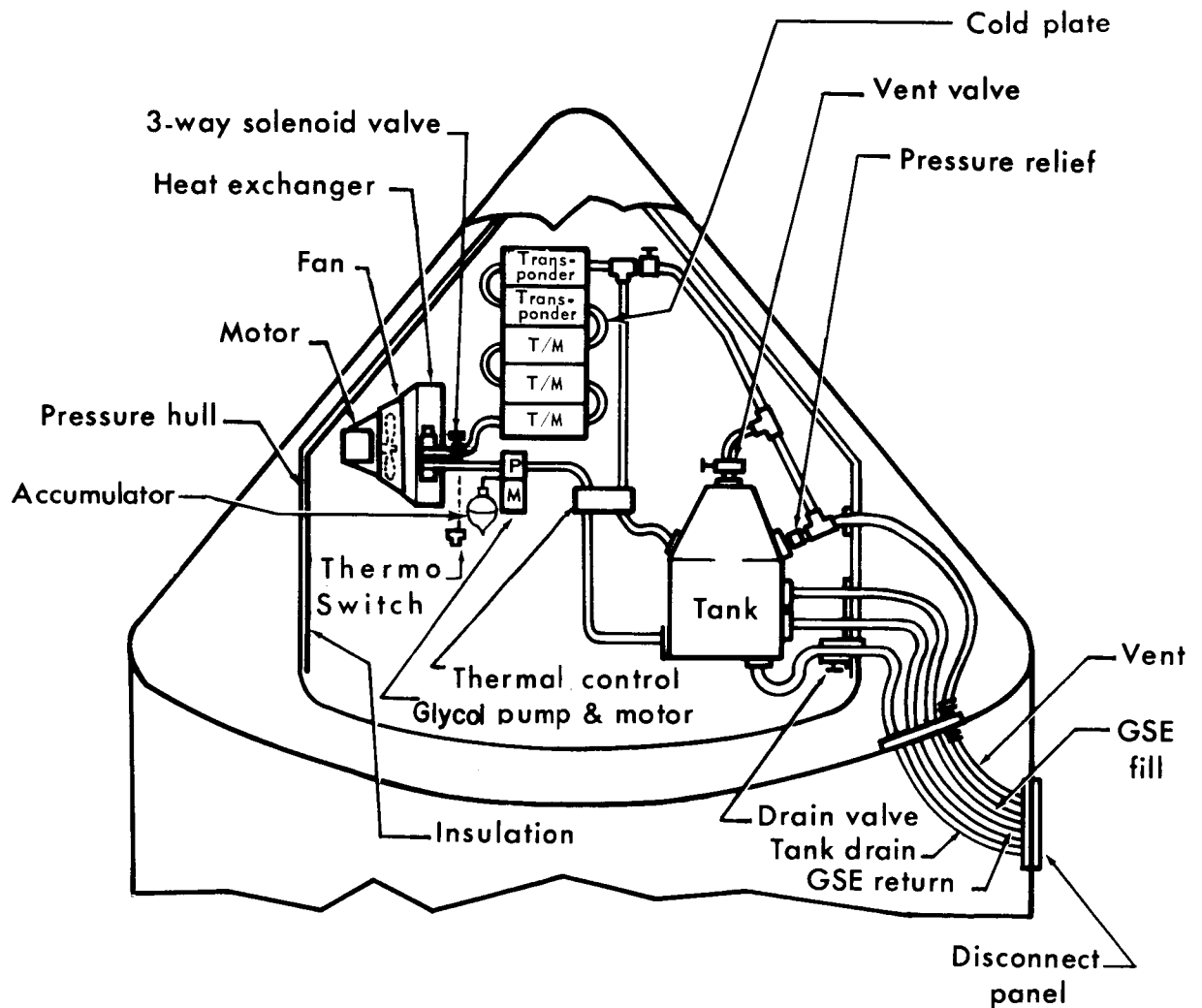


Figure 4-1- Environmental control Subsystem

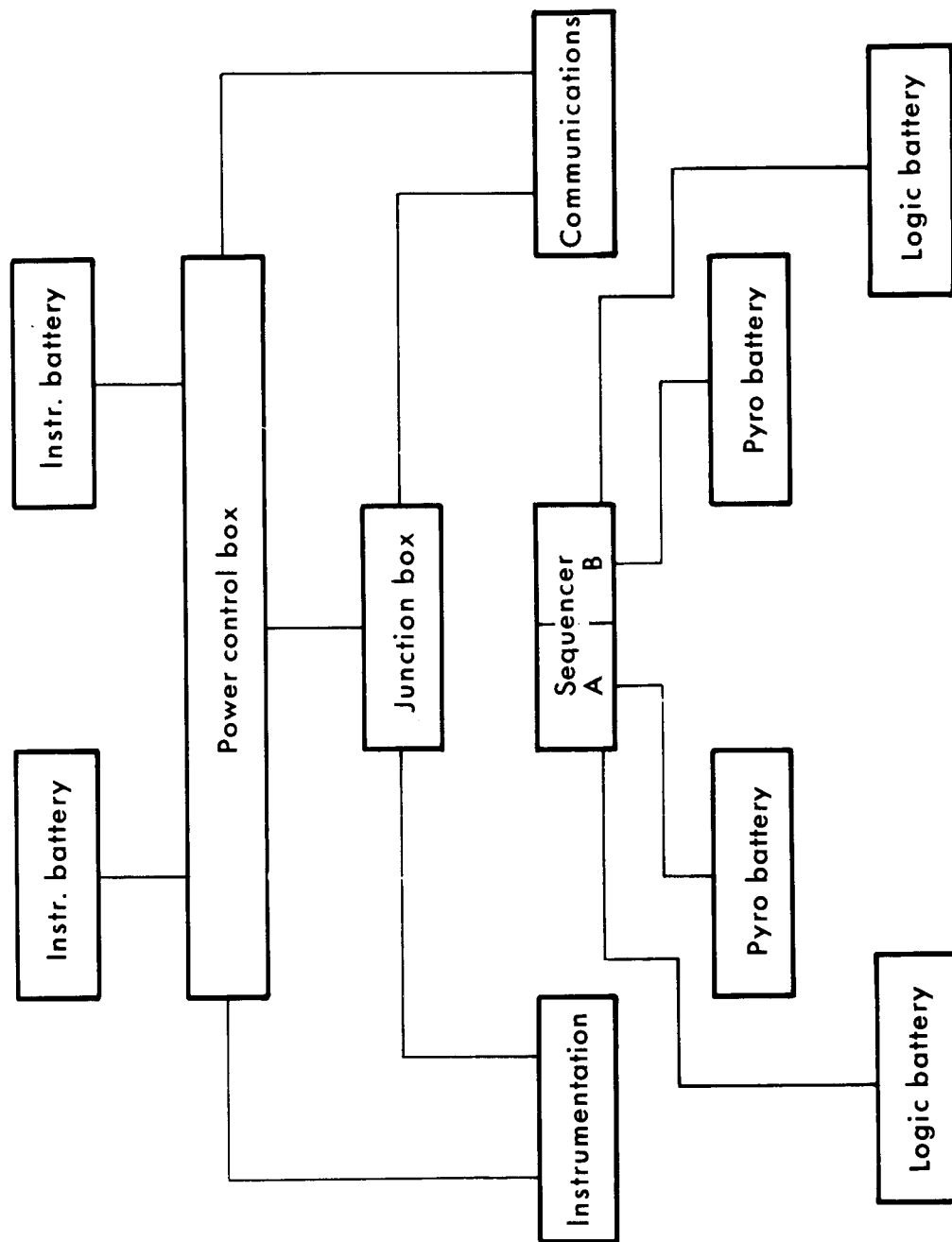
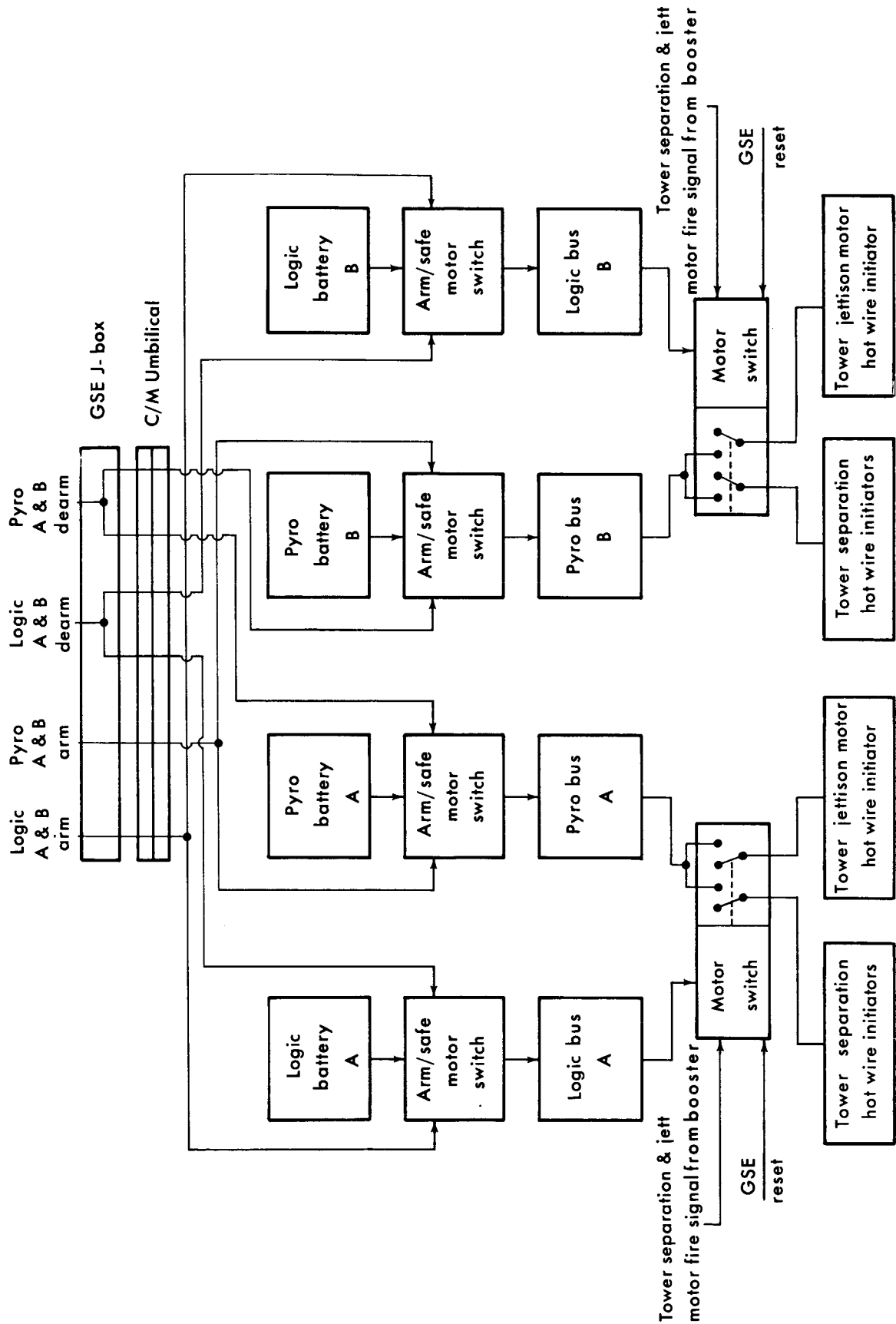


Figure 4-2 - Electrical power Subsystem block diagram



Note: This diagram does not reflect the final configuration for the sequencer

Figure 4-3.- Sequencer Functional Diagram

5.0 STRUCTURAL DESIGN CRITERIA

5.1 General.-

Details of the structural design criteria are available in "Apollo Spacecraft Requirement Specifications", SID 62-700-2, Reference 1.

6.0 AERODYNAMIC STABILITY

6.1 General.-

Aerodynamic data for the launch configuration is given in Figures 6-1, 6-2, and 6-3.

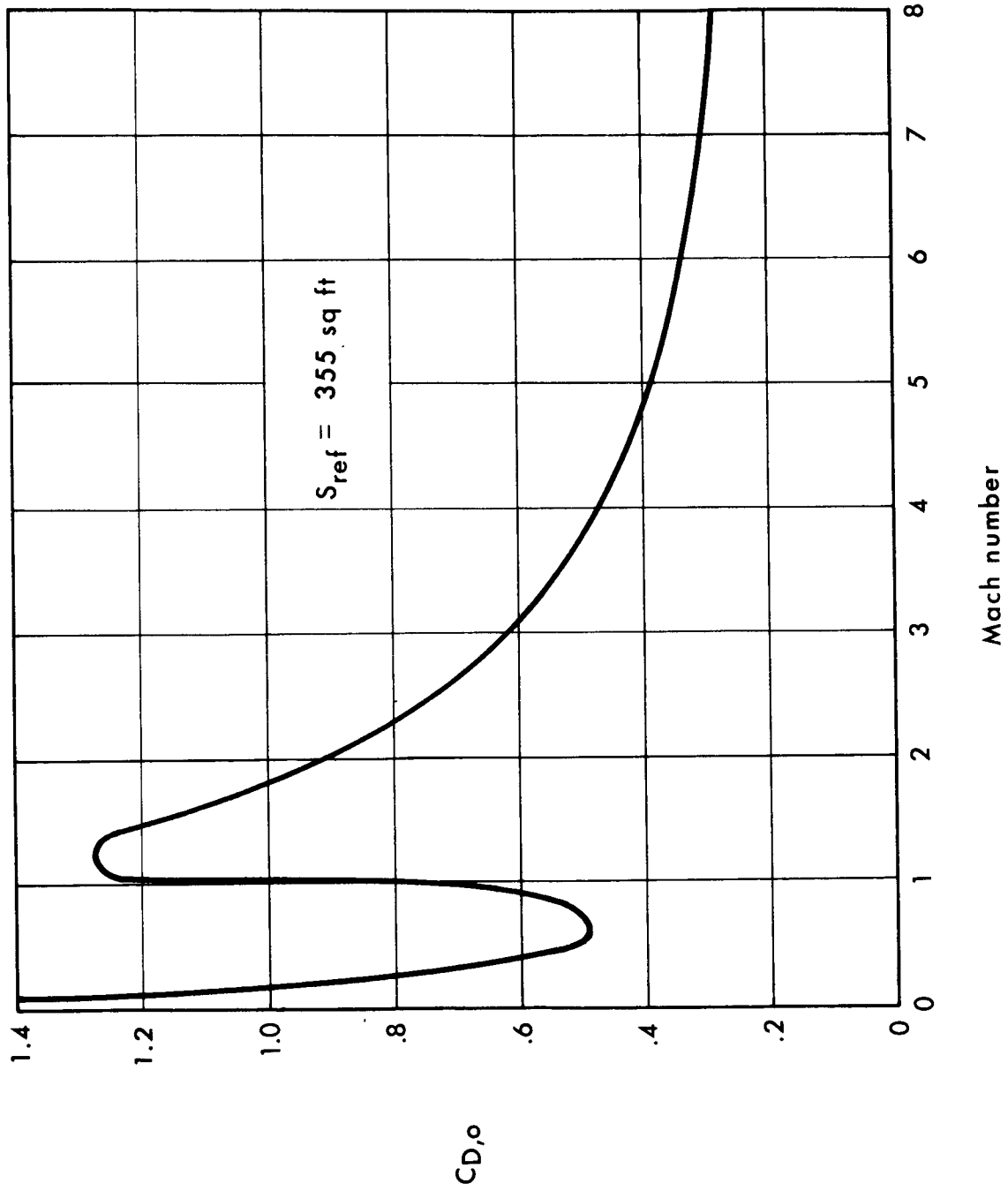


Figure 6-1- Drag coefficient at zero lift with power on for launch configuration

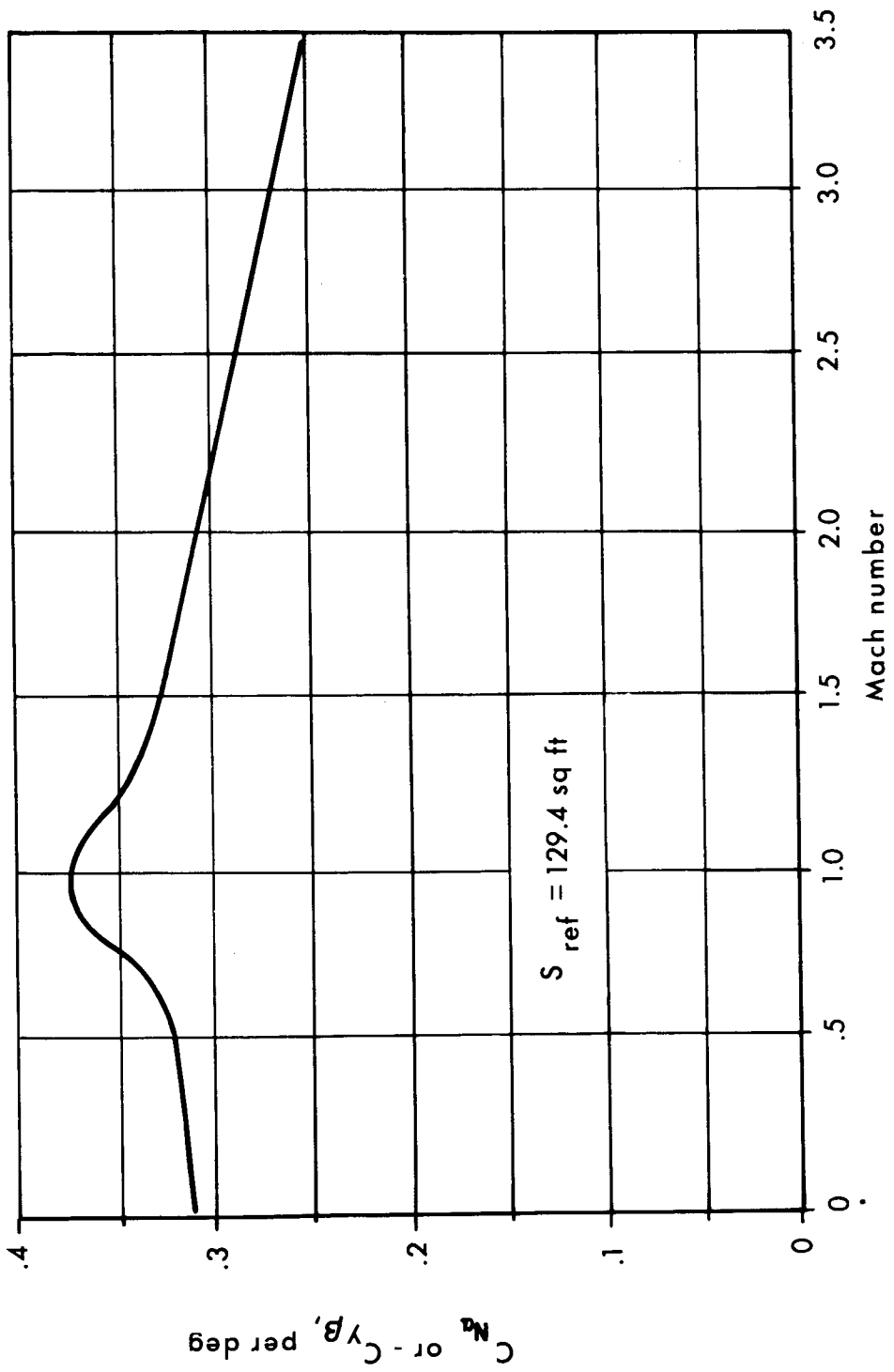


Figure 6-2 - Normal -force and side-force derivatives
for launch configuration

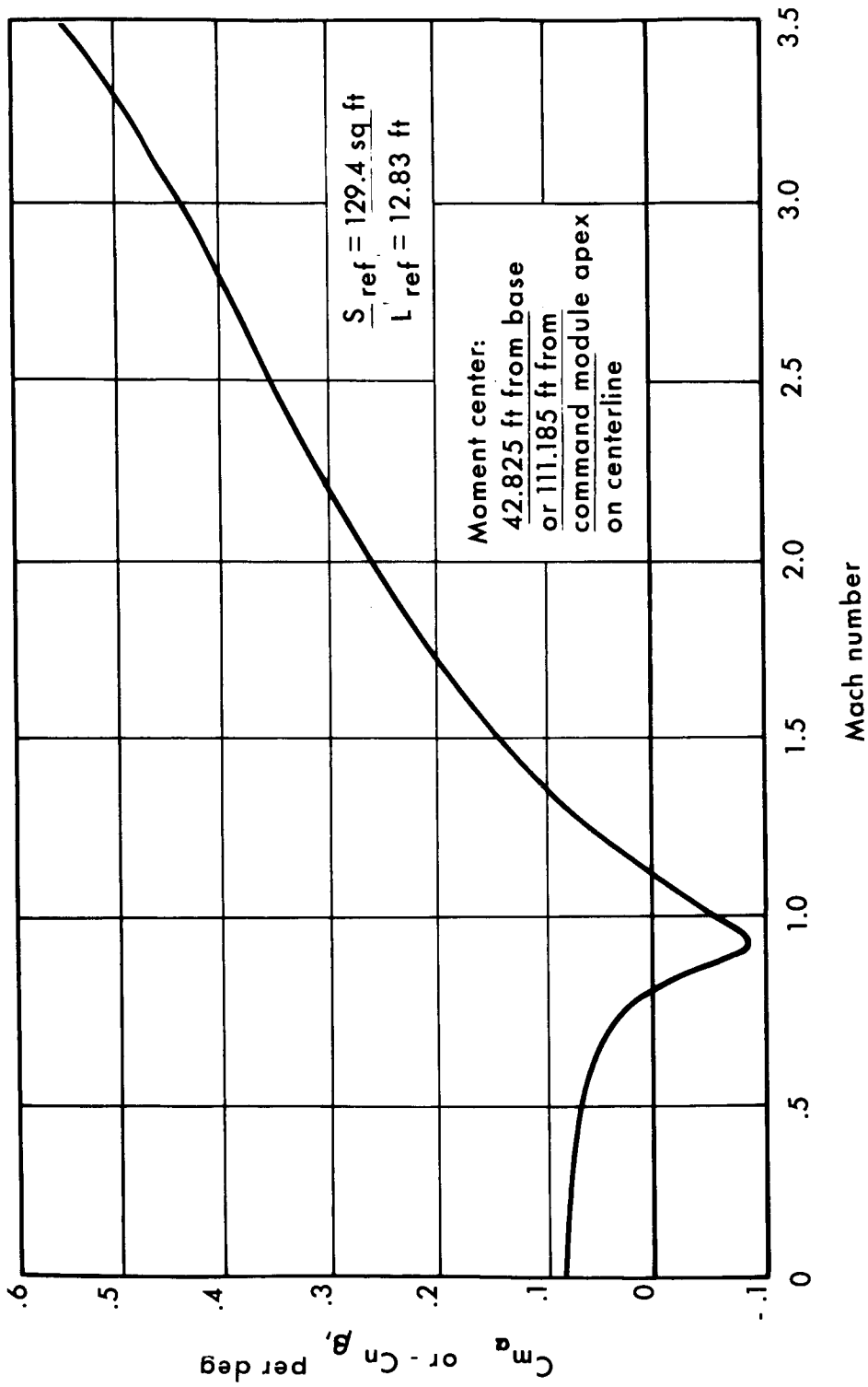


Figure 6-3 - Pitching -moment and yawing-moment derivatives
for launch configuration

7.0 INSTRUMENTATION REQUIREMENTS

7.1 General.-

The 114 Measurements on the payload can be categorized as follows

Measurement	Number and Location					Total	
	Tower	CM	SM	Adapter	Booster	CT	CM
Acceleration	2-CT	3-CT	2-CT			7	
Acoustical			1-CT			1	
Current		1-CM				1	
Discrete Events	2-CM	1-CM			1-CT	1	3
Pressure		3-CT 10-CM	12CT			15	10
Rate, Heat		12-CM	7-CM	1-CM			20
Strain			2-CT	4-CT		6	
Temperature	6-CM	19-CM	8-CM	1-CM			34
Vibration		1-CT	3-CT	2-CT		6	
Voltage		10-CM					10

Total

37 CT
77 CM

Legend: CT - Continuous
CM - Commutated

7-2

7.2

On-Board Instrumentation.-

This section defines the on-board instrumentation and contains a list of measurements to be made for the evaluation of the flight (Ref. 13). Figure 7-1 is a block diagram of the instrumentation and communications system. Figures 7-2a through 7-2e depict the various measurement locations. The telemetry measurement list for the spacecraft is included in Table 7-1, which lists all measurements by channel assignment and by system. The umbilical requirements are presented in Table 7-2.

7.3

Data Acquisition Subsystem.-

Three telemetry subsystems are required. Each T/M consists of a sub-carrier oscillator package and transmitter unit. Telemeter A includes one 90 segment by 10 samples per second commutator and a 90 segment by 1.25 samples per second commutator with the latter being used for all temperature measurements. Telemeters B and C utilize no commutators. The transmitter frequencies are as follows: Telemeter A - 237.8 Mc, Telemeter B - 247.3 Mc, Telemeter C - 257.3 Mc.

7.3.1

Signal Conditioner Package.-

One signal conditioner package is required. It is used to adapt all signals, received from measurement transducers and associated signal conditioning, to the T/M signal input requirements and to direct the conditioned signal to the respective T/M. R&Z calibration and control circuitry is included in the signal conditioner package; Z (Zero) = 15% of full scale; R (Range) = 85% of full scale signal.

7.3.2

C - Band Transponder.-

Two C - Band transponders are required to permit accurate orbital tracking capability. The beacons are set to operate as follows:

Receive

Frequency	5690 MC
Pulse Code	2 Pulses
Pulse Spacing	3.5 Microsec
Pulse Width	1.0 Microsec

<u>Transmit</u>	Frequency	5765 MC
	Time Delay	2.0 Microsec
	Pulse Width	0.75 Microsec

7.3.3 Telemetry Antenna.-

The telemetry antenna system consists of a multiplexer, a filter, and a VHF omni-antenna. The VHF omni-antenna will be located under a radome in the nose of the CM.

7.3.4 C-Band Antennas.-

The C-Band antenna subsystem will consist of four helix, cavity backed, flush mounted antennas having right hand circular polarization and two power dividers. Each C-Band beacon will utilize one power division and two antennas. The antennas will be located 90 degrees apart around the upper portion of the service module at station Xa=954:

7.4 Measurement Requirement List Nomenclature.-

The measurement requirement list consists of all flight measurement parameters, and these parameters are grouped by functional spacecraft subsystems to aid in performance evaluation. The format and nomenclature are briefly described as follows:

7.4.1 Measurement Identification.-

The measurement identification number, shown in the first two columns of Table 7-1, consists of seven characters (letters and numbers). The first letter (module code) designates the measurement location by module.

- A Adapter
- B Booster (Launch Vehicle)
- C Command Module
- L Launch Escape Tower
- S Service Module

The second letter (functional System Code) denotes the subsystem within which the measurement originates.

- A Structure
- C Electrical
- D Launch Escape

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E	Earth Landing
F	Environmental Control
G	Guidance and Navigation
H	Stabilization and Control
J	Life Subsystems
K	Flight Technology
L	In-Flight Test
P	Propulsion
R	Reaction Control
S	Crew Safety
T	Communications and Instrumentation

Numerical characters three through six are assigned sequentially or grouped for clarity within each subsystem. The seventh character denotes measurement classification.

A	Acceleration
B	Phase
C	Current
D	Vibration
E	Power
F	Frequency
G	Force
H	Position
J	Biomedical
K	Radiation
L	Velocity
M	Mass
P	Pressure
Q	Quantity
R	Rate
S	Strain
T	Temperature
V	Voltage
W	Time
X	Discrete
Y	Acoustical
Z	Ph-acidity

7.4.2 Measurement Description.-

The measurement description is a brief, definitive title given to each measurement. Standard abbreviations are used, where applicable, to keep the measurement description length within 32 characters, including spaces.

7.4.3 Telemetry Channel.-

- a. Link (LK). LK designates the telemetry package or the r-f carrier as package A, package B, or package C.

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- b. Subcarrier Number (SCNo.). SC No. designates the telemetry channel in terms of Channels 1 through 18.
- c. Commutator Segment (COM SEG). COM SEG designates the telemetry commutator segment assigned to the measurement for that vehicle.

7.4.4 Data Range.-

The data range denotes the minimum and maximum values for a parameter in engineering units.

7.4.5 Priority.-

The Priority Column (PR) indicates the criticality of the measurement.

- a. P (primary) denotes the measurements that must be available at launch for mission success and/or to meet the flight objectives.
- b. S (secondary) denotes the measurements that are highly desirable but will not abort or delay the mission.
- c. M (multiple) designates a group of related measurements of which no more than a specified percentage may be inoperative.

7.4.6 Response Rate.-

The response rate denotes the rate and unit required to provide satisfactory data resolution to time or wave form. Response for continuous data monitoring will be specified in cycles per second (CPS), and sampled-data monitoring will be specified in samples per second (S/S).

7.4.7 Location.-

The location coordinate denotes the physical location within the spacecraft where the measurement is taken. When the location is given in polar coordinates, it is referenced from the +Z axis (+Z = 0 degrees). The angle increases as the measurement location changes progressively from the +Z axis to the +Y axis. Figure 7-3 illustrates the axis system used for the Apollo spacecraft.

7.5 Electrical Umbilical Functions.-

The electrical umbilical functions required for Boilerplate 13 are listed in Table 7-2. These functions will be routed through the Service Module Umbilical or the Adapter/Saturn IU Interface Umbilical and will be used for checkout and monitoring of the spacecraft during testing.

7.6 Changes.-

Information in Tables 7-1, and 7-2 are subject to change without a revision of the Mission Directive.

TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System Structures		Boilerplate 13									
Meas. ID	Measurement Description	Channel L SC Com K NO Seg	Data Range		P Response R Rate	Unit					
			Low	High							
CA0001	A X Axis Spcrt. Accel. High	C-8	-2	+10	G	P 0-30	CPS XC78, YCO, ZC21				
SA0003	A Z Axis Spcrt. Accel. SM	C-7	-0.5	+0.5	G	P 0-20	CPS XA866, YAO, ZA73				
SA0004	A Y Axis Spcrt. Accel. SM	A-6	-0.5	+0.5	G	P 0-20	CPS XA866, YAO, ZA73				
CA0005	A Y Axis Spcrt. Accel.	C-6	-0.5	0.5	G	P 0-20	CPS XC78, YCO, ZC21				
CA0007	A Z Axis Spcrt. Accel.	B-6	-0.5	+0.5	G	P 0-20	CPS XC78, YCO, ZC21				
LA0011	A Y Axis Tower Accel.	B-7	-2	+2	G	P 0-30	CPS XL380, YLO, ZL6				
LA0012	A Z Axis Tower Accel.	B-8	-2	+2	G	P 0-30	CPS XL380, YL6, ZLO				
CA0021	D CM Radial Vib. 1	A-16	-50	+50	G	P 20-1000	C XC14, YC40.4, ZC37.3				
CA0071	P Con. Surface Press. 1	A-E-66	+0	+15	PSIA	M 10	S/S CX76, 357 DEG				
CA0072	P Con. Surface Pres. 2	A-E-67	+0	+15	PSIA	M 10	S/S XC76, 87 DEG				
CA0073	P Con. Surface Press. 3	A-E-68	+0	+15	PSIA	M 10	S/S XC36, 357 DEG				
CA0074	P Con. Surface Press. 4	A-E-69	+0	+15	PSIA	M 10	S/S XC36, 93 DEG				
CA0075	P Con. Surface Press. 5	A-E-70	+0	+15	PAID	M 10	S/S XC29, 180 DEG				
CA0076	P Con. Surface Press. 6	A-E-71	+0	+15	PSIA	M 10	S/S XC27, 357 DEG				

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TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System
Structures

Boilerplate 13

Meas. ID	Measurement Description	Channel L SC Com K NO Seg	Data Range		P Response R Rate	Unit
			Low	High		
CA0077	P Con. Surface Press. 7	A-E-72	+0	+15 PSIA	M 10	S/S XC27, 87 DEG
CA0078	P Con. Surface Press. 8	A-E-73	+0	+15 PSIA	M 10	S/S XC20, 357 DEG
CA0079	P Con. Surface Press. 9	A-E-74	+0	+15 PSIA	M 10	S/S XC20, 180 DEG
SA0086	D SM Radial Vib. 2	C-18	-50	+50 G	P 20-1000 C	XA965.2, YA42.8, ZA-58
SA0087	D SM Radial Vib. 3	C-17	-50	+50 G	P 20-1000 C	XA953, YA-53.9, ZA47.7
SA0088	D SM Radial Vib. 4	B-17	-50	+50 G	P 20-1000 C	XA940.4, YA68.3, ZA22.8
AA0089	D Adapter Radial Vib. 5	LV TM	-50	+50 G	P 25-2000 C	XA777.7, YAO, ZA72
AA0090	D Adapter Radial Vib. 6	LV TM	-50	+50 G	P 25-2000 C	XA777.7, YA-15.5, ZA-71
CA0179	P Fluctuating Press. 1	B-18	+0	+15 PSIA	M 1000	CPS XC100, 357 DEG
CA0180	P Fluctuating Press. 2	C-15	+0	+15 PSIA	M 300	CPS XC70, 357 DEG
CA0181	P Fluctuating Press. 3	B-15	+0	+15 PSIA	M 300	CPS XC40, 357 DEG
SA0182	P Fluctuating Press. 4	A-15	+0	+15 PSIA	M 300	CPS XC12, 357 DEG
SA0183	P Fluctuating Press. 5	C-14	+0	+15 PSIA	M 300	CPS XA974, 43 DEG
SA0184	P Fluctuating Press. 6	B-14	+0	+15 PSIA	M 300	CPS XA974, 357 DEG
SA0185	P Fluctuating Press. 7	A-14	+0	+15 PSIA	M 300	CPS XA974, 87 DEG
SA0186	P Fluctuating Press. 8	C-13	+0	+15 PSIA	M 300	CPS XA974, 267 DEG

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TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System Structures		Boilerplate 13									
Meas. Id	Measurement Description	Channel L SC Com K NO Seg	Data Range Low High	Unit	P Response R Rate	Unit					
SA0187 P	Fluctuating Press. 9	B-13	+0 +15 PSIA	M 300	CPS XA974,267 DEG						
SA0188 P	Fluctuating Press. 10	A-12	+0 +15 PSIA	M 300	CPS XA930,357 DEG						
SA0189 P	Fluctuating Press. 11	C-12	+0 +15 PSIA	M 300	CPS XA881,357 DEG						
SA0190 P	Fluctuating Press. 12	B-12	+0 +15 PSIA	M 300	CPS XA881,177 DEG						
SA0191 P	Fluctuating Press. 13	A-11	+0 +15 PSIA	M 300	CPS XA881,87 DEG						
SA0192 P	Fluctuating Press. 14	C-11	+0 +15 PSIA	M 300	CPS XA881,267 DEG						
SA0193 P	Fluctuating Press. 15	B-11	+0 +15 PSIA	M 300	CPS XA833,357 DEG						
AA0195 S	Strain 1 Adapter	A-9	-1000 +1000 UI/IN	M 100	CPS XA736,YA76,ZAO						
AA0196 S	Strain 2 Adapter	A-10	-1000 +1000 UI/IN	M 100	CPS XA736,YAO,ZA-76						
AA0197 S	Strain 3 Adapter	B-10	-1000 +1000 UI/IN	M 100	CPS XA736,YA-76,ZAO						
AA0198 S	Strain 4 Adapter	C-10	-1000 +1000 UI/IN	M 100	CPS XA736,YAO,ZA76						
SA0550 R	Heat Flux (Calmtr.) 17	A-13-28	+0 +5 B/F/S	M 1.25	S/S XS338,183 DEG						
SA0551 R	Heat Flux (Calmtr.) 18	A-13-29	+0 +5 B/F/S	M 1.25	S/S XS315,187.2 DEG						
SA0552 R	Heat Flux (Calmtr.) 20	A-13-31	+0 +5 B/F/S	M 1.25	S/S XS305,177 DEG						

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7-9

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TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System Structures	Meas. ID	Measurement Description	Channel L SC Com	Boilerplate 13 Data Range		P Response R Rate	Unit
				Low	High		
SAO553 R Heat Flux (Calmttr.)	13		A-13-24	+0	+5 B/F/S	M 1.25	S/S XS305, 187.2 DEG
SAO554 R Heat Flux (Calmttr.)	14		A-13-25	+0	+5 B/F/S	M 1.25	S/S XS267, 160 DEG
SAO555 R Heat Flux (Calmttr.)	16		A-13-27	+0	+5 B/F/S	M 1.25	S/S XS267, 145 DEG
SAO560 T Calmttr. Body Temp	17		A-13-48	+0	+300 DEG C	S 1.25	S/S XS338, 183 DEG
SAO561 T Calmttr. Body Temp.	18		A-13-49	+0	+300 DEG C	S 1.25	S/S XS315, 187.2 DEG
SAO562 T Calmttr. Body Temp.	20		A-13-51	+0	+300 DEG C	S 1.25	S/S XS305, 177 DEG
SAO563 T Calmttr. Body Temp.	13		A-13-44	+0	+300 DEG C	S 1.25	S/S XS305, 187.2 DEG
SAO564 T Calmttr. Body Temp.	14		A-13-45	+0	+300 DEG C	S 1.25	S/S XS267, 160 DEG
SAO565 T Calmttr. Body Temp.	16		A-13-47	+0	+300 DEG C	S 1.25	S/S XS267, 145 DEG
SAO580 R Heat Flux (Calmttr.)	1		A-13-12	+0	+25 B/F/S	M 1.25	S/S XC74, 3 DEG
CAO581 R Heat Flux (Calmttr.)	2		A-13-13	+0	+25 B/F/S	M 1.25	S/S XC74, 180 DEG
CA 0582 R Heat Flux (Calmttr.)	3		A-13-14	+0	+25 B/F/S	M 1.25	S/S XC74, 319 DEG
CAO583 R Heat Flux (Calmttr.)	4		A-13-15	+0	+25 B/F/S	M 1.25	S/S XC53, 180 DEG
CAO584 R Heat Flux (Calmttr.)	5		A-13-16	+0	+25 B/F/S	M 1.25	S/S XC52, 3 DEG
CAO585 R Heat Flux (Calmttr.)	7		A-13-17	+0	+25 B/F/S	M 1.25	S/S XC52, 80 DEG

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TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System Structures		Boilerplate 13				
Meas. ID	Description	Channel L SC Com K NO Seg	Data Range		P Response R Rate	Unit
			Low	High		
CA0856 R	Heat Flux (Calmttr.) 7	A-13-18	+0	+25 B/F/S	M 1.25	S/S XC52,85 DEG
CA0587 R	Heat Flux (Calmttr.) 8	A-13-19	+0	+25 B/F/S	M 1.25	S/S XC52,95 DEG
CA0588 R	Heat Flux (Calmttr.) 9	A-13-20	+0	+25 B/F/S	M 1.25	S/S XC52,319 DEG
CA0589 R	Heat Flux (Calmttr.) 10	A-13-21	+0	+25 B/F/S	M 1.25	S/S XC42.65,3 DEG
CA0590 R	Heat Flux (Calmttr.) 11	A-13-22	+0	+25 B/F/S	M 1.25	S/S XC27,180 DEG
CA0591 R	Heat Flux (Calmttr.) 12	A-13-23	+0	+25 B/F/S	M 1.25	S/S XC27,319 DEG
AA0594 R	Heat Flux (Calmttr.) 19	A-13-30	+0	+5 B/F/S	M 1.25	S/S XA770,183 DEG
SA0598 R	Heat Flux (Calmttr.) 15	A-13-26	+0	+5 B/F/S	M 1.25	S/S XA933,183 DEG
LA0601 T	Tower Temp. 2	A-13-53	+0	+150 DEG C	M 1.25	S/S XL61,YL22,ZL0
LA0602 T	Tower Temp. 3	A-13-54	+0	+150 DEG C	M 1.25	S/S XL47,YL0,ZL23
LA0603 T	Tower Temp. 4	A-13-55	+0	+150 DEG C	M 1.25	S/S XL47,YL24,ZL23
LA0604 T	Tower Temp. 5	A-13-56	+0	+150 DEG C	M 1.25	S/S XL47,YL-24,ZL-23
LA0606 T	Tower Temp. 7	A-13-58	+0	+150 DEG C	M 1.25	S/S XL47,YL-24,ZL23
LA0607 T	Tower Temp. 8	A-13-59	+0	+150 DEG C	M 1.25	S/S XL36,YL24,ZL0

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7-11

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TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System Structures			Boilerplate 13				
Meas. ID	Description	Channel	Data Range		P Response	Unit	
			L SC Com	High Unit			
		K NO Seg	Low		R Rate		
CA0610	T CM Interior Temp.	A-13-4	+0	+150 DEG C	S 1.25	S/S CM Interior	
CA0611	P CM Interior Press.	A-E-88	+0	+15 PSIA	S 10	S/S CM Interior	
SA0612	T SM Interior Temp.	A-13-5	+0	+150 DEG C	S 1.25	S/S SM Interior	
CA0651	T. Calmtr. Body Temp. 1	A-13-32	+0	+300 DEG C	S 1.25	S/S XC74, 3 DEG	
CA0652	T Calmtr. Body Temp. 2	A-13-33	+0	+300 DEG C	S 1.25	S/S XC74, 180 DEG	
CA0653	T Calmtr. Body Temp. 3	A-13-34	+0	+300 DEG C	S 1.25	S/S XC74, 319 DEG	
CA0654	T Calmtr. Body Temp. 4	A-13-35	+0	+300 DEG C	S 1.25	S/S XC53, 180 DEG	
CA0655	T Calmtr. Body Temp. 5	A-13-36	+0	+300 DEG C	S 1.25	S/S XC52, 3 DEG	
CA0656	T Calmtr. Body Temp. 6	A-13-37	+0	+300 DEG C	S 1.25	S/S XC52, 80 DEG	
CA0657	T Calmtr. Body Temp. 7	A-13-38	+0	+300 DEG C	S 1.25	S/S XC52, 85 DEG	
CA0658	T Calmtr. Body Temp. 8	A-13-39	+0	+300 DEG C	S 1.25	S/S XC52, 95 DEG	
CA0659	T Calmtr. Body Temp. 9	A-13-40	+0	+300 DEG C	S 1.25	S/S XC52, 319 DEG	
CA0660	T Calmtr. Body Temp. 10	A-13-41	+0	+300 DEG C	S 1.25	S/S XC42.65, 3 DEG	
CA0661	T Calmtr. Body Temp. 11	A-13-42	+0	+300 DEG C	S 1.25	S/S XC27, 180 DEG	

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TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System Structures		Boilerplate 13						
Meas. ID	Measurement Description	Channel L SC Com K NO Seg	Data Range		P Response		Unit	
			Low	High	Unit	R Rate		
CA0662	T Calmtr. Body Temp. 12	A-13-43	+0	+300 DEG C	S 1.25		S/S XC27,319 DEG	
AA0665	T Calmtr. Body Temp. 19	A-13-50	+0	+300 DEG C	S 1.25		S/S XA770,183 DEG	
SA0669	T Calmtr. Body Temp. 15	A-13-46	+0	+300 DEG C	S 1.25		S/S XA933,183 DEG	
SA2120	S Strain 1 SM	B-16	-4000	+4000 UI/IN	M 250		CPS XA940.4,62.25 DEG	
SA2121	S Strain 2 SM	C-16	-4000	+4000 UI/IN	M 250		CPS XA940.4,77.25 DEG	
SA2760	Y SM Acoustic	LV TM	+150	+170 DB	S 25-3000		C XS339,0 DEG	

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TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System Electrical		Boilerplate 13					
Meas. ID	Description	Channel		Data Range		P Response	Unit
		L SC Com K NO Seg		Low	High		
CC0001	V DC Voltage Main Bus A	A-E-24		+22	+32 VDC	P 10	S/S Pwr. Control Box
CC0002	V DC Voltage Main Bus B	A-E-25		+22	+32 VDC	P 10	S/S Pwr. Control Box
CC0003	V DC Voltage Logic Bus A	A-E-22		+0	+36 VDC	P 10	S/S LES Sequencer
CC0004	V DC Voltage Logic Bus B	A-E-23		+0	+36 VDC	P 10	S/S LES Sequencer
CC0005	C Total DC Current	A-E-26		+0	+50 AMPS	P 10	S/S Pwr. Control Box

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TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System Launch Escape		Boilerplate 13						
Meas. ID	Measurement Description	Channel		Data Range		P Response	Unit	
		L SC Com	K NO Seg	Low	High			
BD0001	X S-I Lift Off Signal	A-9, A-10		Step	M 100		CPS Sig. Cond. Box	
LD0033	X Twr. Jett. & Sep. Relay Close A	A-E-29		Step	P 10		S/S Twr. LES Seq.	
LD0034	X Twr. Jett. & Sep. Relay Close B	A-E-29		Step	P 10		S/S Twr. LES Seq.	
CD0039	V Twr. Jett. & Sep. Command A	A-E-37	+0	+36 VDC	P 10		S/S LES Seq.	
CD0040	V Twr. Jett. & Sep. Command B	A-E-38	+0	+36 VDC	P 10		S/S LES Seq.	
CD0185	V DC Voltage Twr. Pyro. Bus A	A-E-28	+0	+36 VDC	P 10		S/S LES Seq.	
CD0186	V DC Voltage Twr. Pyro. Bus B	A-E-35	+0	+36 VDC	P 10		S/S LES Seq.	

UNCLASSIFIED

TABLE 1-1. APOLLO BOILERPLATE MEASUREMENT LIST

System			Boilerplate 13			
Environmental Control			Channel	Data Range		P Response
Meas. ID	Description		L SC Com K NO Seg	Low High	Unit	R Rate Unit Location
CF0400	T R/D ECS CM Interior Temp.		GSE	+0	+150 DEG F	CM Interior
CF0401	T R/D ECS Cold Plate Inlet Temp.		GSE	+0	+100 DEG F	Cold Plate Inlet
CF0402	T R/D ECS Cold Plate Outlet Temp.		GSE	+0	+100 DEG F	Cold Plate Outlet
CF0403	P R/D ECS Tank Inlet Press		GSE	+0	+50 PSID	Cool Tank Inlet
CF0404	T R/D ECS Tank Outlet Temp		GSE	+0	+100 DEG F	Cool Tank Outlet
CF0405	P R/D ECS Pump Outlet Press		GSE	+0	+50 PSID	Cool Pump Outlet

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TABLE 7-1. APOLLO BOILERPLATE MEASUREMENT LIST

System Communications and Instrumentation				Boilerplate 13		
Meas. ID	Measurement Description	Channel L SC Com K NO Seg	Data Range Low High	Unit	P Response R Rate	Unit
CTO002 V	Transponder A Trigger	A-E-57	+0 +5	VDC	S 10	S/S Transponder A
CTO003 V	Transponder B Trigger	A-E-58	+0 +5	VDC	S 10	S/S Transponder B
CTO007 X R and Z	Calib. Monitor	A-E-59		Step	P 10	S/S Sig. Cond. Box
CTO201 T	TM RF Xmtr. A Temp.	A-13-6	+0 +150	DEG C	S 1.25	S/S TM RF Xmtr. A
CTO202 T	TM RF Amp A Temp.	A-13-7	+0 +150	DEG C	S 1.25	S/S TM RF Amp A
CTO203 T	TM RF Xmtr. B Temp.	A-13-8	+0 +150	DEG C	S 1.25	S/S TM RF Xmtr. B
CTO204 T	TM RF Amp B Temp.	A-13-9	+0 +150	DEG C	S 1.a5	S/S TM RF Amp B
CTO205 T	TM RF Xmtr. C Temp.	A-13-10	+0 +150	DEG C	S 1.25	S/S TM RF Xmtr. C
CTO207 T	TM RF Amp C Temp.	A-13-11	+0 +150	DEG C	S 1.25	S/S TM RF Amp C

TABLE 7-2. ELECTRICAL UMBILICAL FUNCTIONS

SERVICE MODULE UMBILICAL	FUNCTION	VOLTAGE RANGE
Regulated Power Supply (5 VDC)	Monitor	0-5 VDC
Main Battery Current Total	Monitor	0-5 VDC
Umbilical Separation	Monitor	0-28 VDC
Umbilical Separation	Monitor	0-28 VDC
Coldplate Inlet Temperature (+)	Monitor	0-5 VDC
Coldplate Inlet Temperature (-)	Return	0-5 VDC
Coldplate Outlet Temperature (+)	Monitor	0-5 VDC
Coldplate Outlet Temperature (-)	Return	0-5 VDC
ECS Pump Outlet Pressure	Monitor	0-5 VDC
ECS Pump Outlet Pressure Common	Return	0-5 VDC
Command Module Air Temperature (+)	Monitor	0-5 VDC
Command Module Air Temperature (-)	Return	0-5 VDC
ECS Tank Outlet Temperature (+)	Monitor	0-5 VDC
ECS Tank Outlet Temperature (-)	Return	0-5 VDC
ECS Tank Inlet Pressure	Monitor	0-5 VDC
ECS Tank Inlet Pressure Common	Return	0-5 VDC
Shield		
Shield		
Signal Common to GSE	Return	0-5 VDC
Signal Common to GSE	Return	0-5 VDC
Instrumentation Bus Control	Holding	0-28 VDC

TABLE 7-2. ELECTRICAL UMBILICAL FUNCTIONS

SERVICE MODULE UMBILICAL	FUNCTION	VOLTAGE RANGE
External Power Bus A	Power	0-28 VDC
External Power Bus A	Power	0-28 VDC
External Power Bus A	Power	0-28 VDC
External Power Bus A	Power	0-28 VDC
External Power Bus B	Power	0-28 VDC
External Power Bus B	Power	0-28 VDC
External Power Bus B	Power	0-28 VDC
External Power Bus B	Power	0-28 VDC
External Power Ground	Return	0-28 VDC
External Power Ground	Return	0-28 VDC
External Power Ground	Return	0-28 VDC
External Power Ground	Return	0-28 VDC
External Power Ground	Return	0-28 VDC
External Power Ground	Return	0-28 VDC
External Power Ground	Return	0-28 VDC
External Power Ground	Return	0-28 VDC
External Power Ground	Return	0-28 VDC
Main Bus A Monitor and Regulation (+)	Meter	0-28 VDC
Main Bus A Monitor and Regulation (-)	Meter	0-28 VDC
Main Bus B Monitor and Regulation (+)	Meter	0-28 VDC
Main Bus B Monitor and Regulation (-)	Meter	0-28 VDC
Logic Battery B Voltage	Meter	0-28 VDC

TABLE 7-2. ELECTRICAL UMBILICAL FUNCTIONS (CONT.)

SERVICE MODULE UMBILICAL	FUNCTION	VOLTAGE RANGE
Pyro Battery A Voltage	Meter	0-28 VDC
Pyro Battery B Voltage	Meter	0-28 VDC
Battery A Monitor and Bleed	Monitor	0-28 VDC
Battery B Monitor and Bleed	Monitor	0-28 VDC
Bus A Power Transfer	Monitor	0-28 VDC
Bus B Power Transfer	Monitor	0-28 VDC
TM A RF X-MTR Control	Holding	0-28 VDC
TM RF Power Amplifier On (Latching Relay)	Momentary	0-28 VDC
C-Band Transponder No. 1 Control	Holding	0-28 VDC
C-Band Transponder No. 2 Control	Holding	0-28 VDC
ECS Instrumentation Power	Power	0-28 VDC
ECS Instrumentation Common	Return	0-28 VDC
GSE Relay Power (+)	Power	0-28 VDC
GSE Relay Power (-)	Return	0-28 VDC
Shield	Shield to be used.	
R Calibrate Control	Momentary	0-28 VDC
Z Calibrate Control	Momentary	0-28 VDC
TM B RF X-MTR Control	Holding	0-28 VDC
TM C RF X-MTR Control	Holding	0-28 VDC
Logic Battery A Voltage	Meter	0-28 VDC
TM RF Power Amplifier-Off Control (Latching Relay)	Momentary	0-28 VDC

TABLE 7-2. ELECTRICAL UMBILICAL FUNCTIONS (CONT.)

SERVICE MODULE UMBILICAL	FUNCTION	VOLTAGE RANGE
TM Calibration Enable Control	Holding	0-28 VDC
TM Calibration Auto-Manual Control	Holding	0-28 VDC
TM Calibration Control Manual Step	Momentary	0-28 VDC
Tower Sequencer A & B SAFE Command	Monitor	0-28 VDC
Tower Sequencer A & B SAFE Command	Monitor	0-28 VDC
Tower Sequencer SAFE Command Common	Return	0-28 VDC
Tower Sequencer SAFE Command Common	Return	0-28 VDC
Tower Sequencer SAFE Command Common	Return	0-28 VDC
ECS External Control	Holding	0-28 VDC
Voltmeter Common	Return	0-28 VDC
TM System A Composite Video	Monitor	Video
TM System B Composite Video	Monitor	Video
TM System C Composite Video	Monitor	Video

TABLE 7-2. ELECTRICAL UMBILICAL FUNCTIONS (CONT.)

ADAPTER/SATURN INSTRUMENT UNIT INTERFACE	FUNCTION	VOLTAGE RANGE
"Q" Ball Heater Power	Power	0-115 VAC
" " Ball Heater Power	Return	0-115 VAC
"Q" Ball Heater Power Shield Terminate	Shield	0-VDC
"Q" Ball Electronic Power (+)	Power	0-28 VDC
"Q" Ball Electronic Power Common (-)	Return	0-VDC
"Q" Ball Electronic Power Shield Terminate	Shield	0-VDC
"Q" Ball Simulate Command	Power	0-28 VDC
"Q" Ball Surface Temp (TM.) Ref. (+)	Signal	0-5 VDC
"Q" Ball Surface Temp (M.) Ref. (-)	Return	0-VDC
"Q" Ball Dynamic Pressure (TM.) (+)	Signal	0-5 VDC
"Q" Ball Dynamic Pressure (TM.) Ref. (-)	Return	0-VDC
"Q" Ball Alpha-q Yaw (TM.) (+)	Signal	0-5 VDC
"Q" Ball Alpha-q Yaw (TM.) Ref. (-)	Return	0-VDC
"Q" Ball Alpha-q Pitch (TM.) (+)	Signal	0-5 VDC
"Q" Ball Alpha-q Pitch (TM.) Ref. (-)	Return	0-VDC
"Q" Ball Alpha-q Yaw Output (+)	Signal	0-30 VDC
"Q" Ball Alpha-q Yaw Output (-)	Signal	0-30 VDC
"Q" Ball Alpha-q Pitch Output (+)	Signal	0-30 VDC
"Q" Ball Alpha-q Pitch Output (-)	Signal	0-30 VDC
"Q" Ball Signal Shield Terminate	Shield	0-VDC
Pyro Switches Indicate Arm	Monitor	0-28 VDC

TABLE 7-2. ELECTRICAL UMBILICAL FUNCTIONS (CONT.)

ADAPTER/SATURN INSTRUMENT UNIT INTERFACE	FUNCTION	VOLTAGE RANGE
Pyro Switches Indicate Safe	Monitor	0-28 VDC
Pyro Buses Arm Command	Power	0-28 VDC
Pyro Bus "A" Safe Command	Power	0-28 VDC
Pyro Bus "B" Safe Command	Power	0-28 VDC
Pyro Bus "A" Indicate ON	Monitor	0-28 VDC
Pyro Bus "B" Indicate ON	Monitor	0-28 VDC
Logic Switches Indicate Arm	Monitor	0-28 VDC
Logic Switches Indicate SAFE	Monitor	0-28 VDC
Logic Buses Arm Command	Power	0-28 VDC
Logic Bus "A" Safe Command	Power	0-28 VDC
Logic Bus "B" Safe Command	Power	0-28 VDC
Logic Bus "A" Indicate ON	Monitor	0-28 VDC
Logic Bus "B" Indicate ON	Monitor	0-28 VDC
Launch Escape System Indicate Power	Power	0-28 VDC
Launch Escape Tower Jettison Command Power	Power	0-28 VDC
Launch Escape Tower Jettison Command	Signal	0-28 VDC
Launch Escape Tower Jettison Indicate Fire	Monitor	0-28 VDC
Launch Escape Tower Indicate Safe	Monitor	0-28 VDC
Launch Escape System Sequencer Common	Return	0-VDC
Shield Terminate	Shield	0-VDC
Instrument Bus "A" Battery Power Off Command	Holding	0-28 VDC

TABLE 7-2. ELECTRICAL UMBILICAL FUNCTIONS (CONT.)

ADAPTER/SATURN INSTRUMENT UNIT INTERFACE	FUNCTION	VOLTAGE RANGE
Instrument Bus "B" Battery Power Off Command	Holding	0-28 VDC
Instrument Bus Control Common	Return	0-VDC
Launch Escape Tower Jettison Command Power	Power	0-28 VDC
Launch Escape Tower Jettison Command	Signal	0-28 VDC
Lift Off Indication Power	Power	0-28 VDC
Lift Off Indication	Signal	0-28 VDC
Shield Terminate	Shield	0-VDC

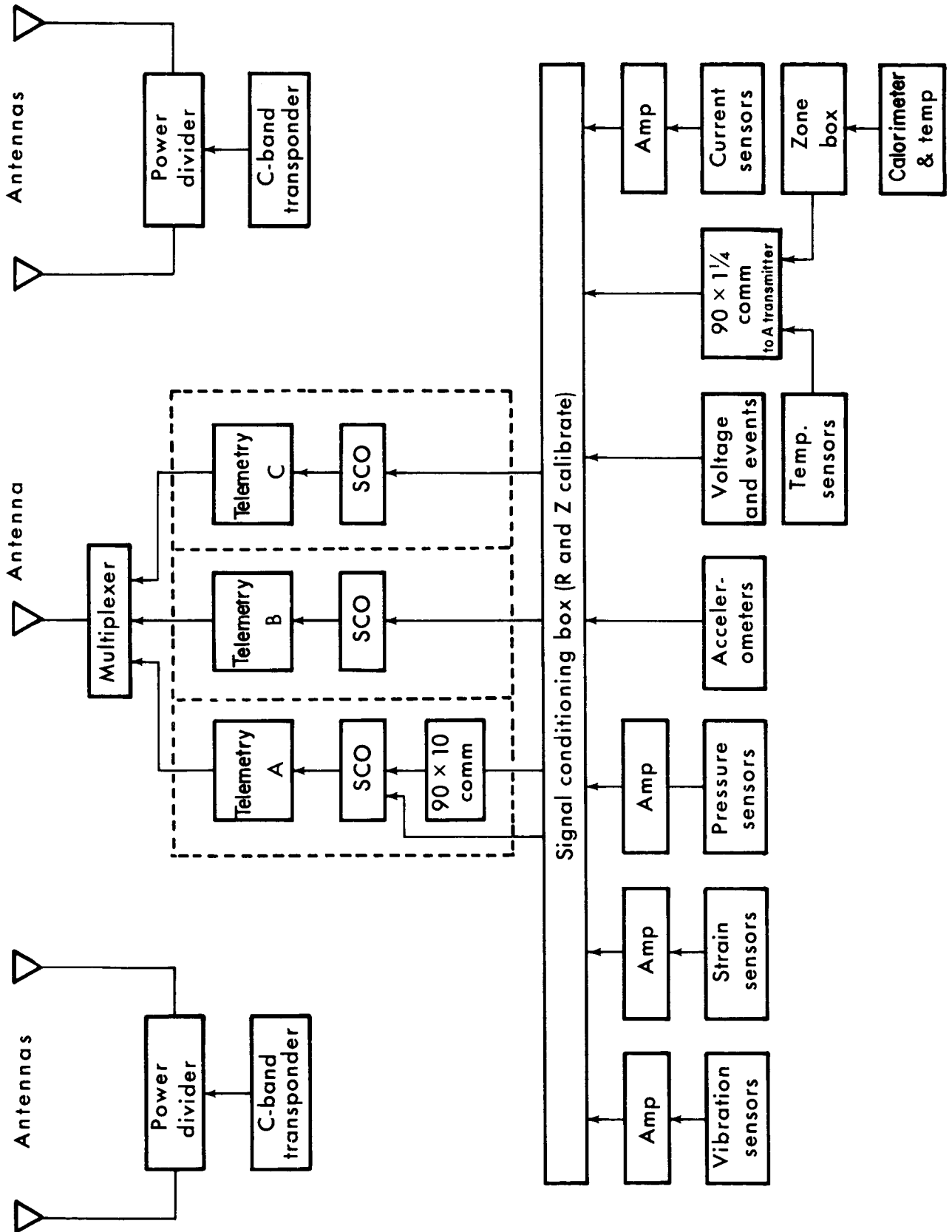
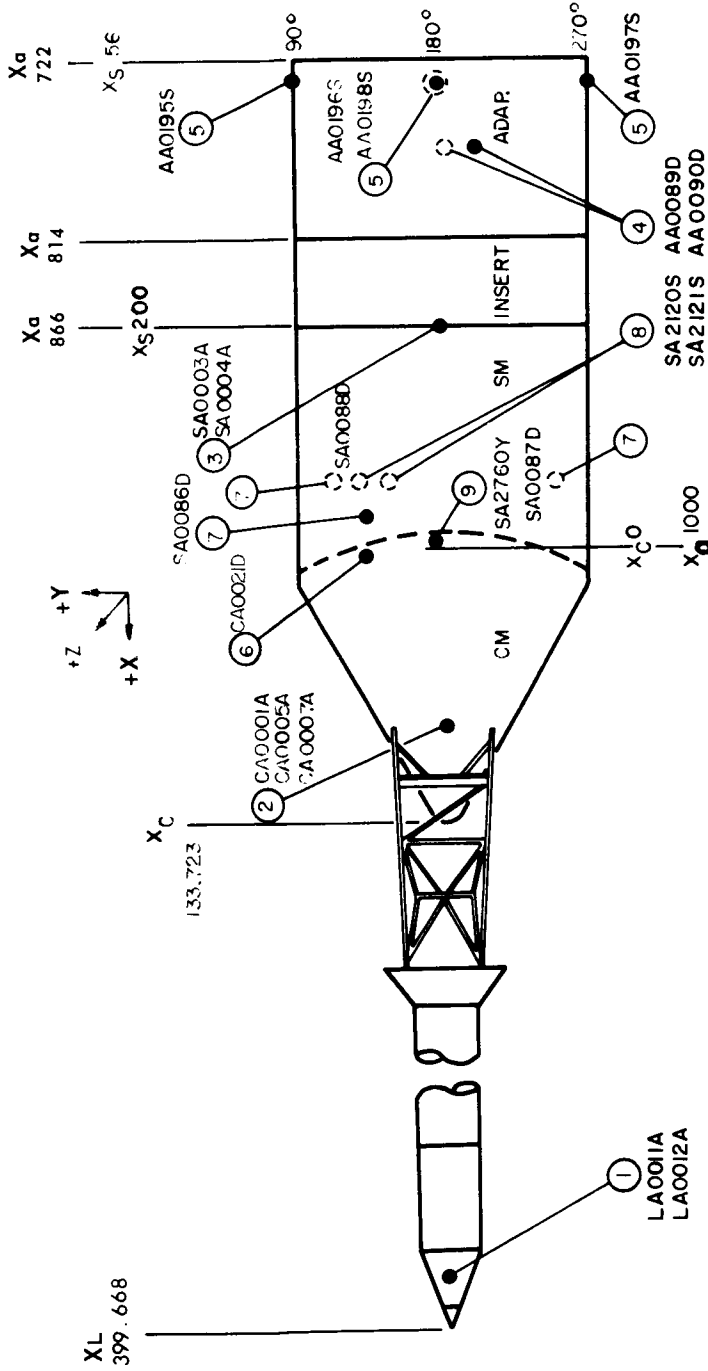


Figure 71-R and D instrumentation and communications Subsystem



LEGEND

- ① Accelerometers (2) inside nose cone
- ② Accelerometers (3) inside cm
- ③ Accelerometers (2) inside sm
- ④ Vibration transducers (2) inside adapter
- ⑤ Strain gages (4) on adapter
- ⑥ Vibration transducer (1) inside cm
- ⑦ Vibration transducer (3) inside sm
- ⑧ STRAIN GAGES (2) ON SM
- ⑨ SM ACOUSTIC
- EXPOSED
- HIDDEN

NOTES

- 1 THE MEASUREMENT LOCATIONS ARE REFERENCED FROM THE +Z AXIS (+Z=0°), AND THE MEASUREMENT ANGLE INCREASES AS THE MEASUREMENT LOCATION CHANGES PROGRESSIVELY FROM THE +Z AXIS TO THE +Y AXIS.
- 2 SEE THE MEASUREMENT LISTS FOR SPECIFIC MEASUREMENT LOCATIONS.
- 3 THE DIAGRAM IS NOT DRAWN TO SCALE.

(a)- Accelerometers, vibration transducers, and strain gauges

Figure 7-2 Spacecraft Measurement Locations

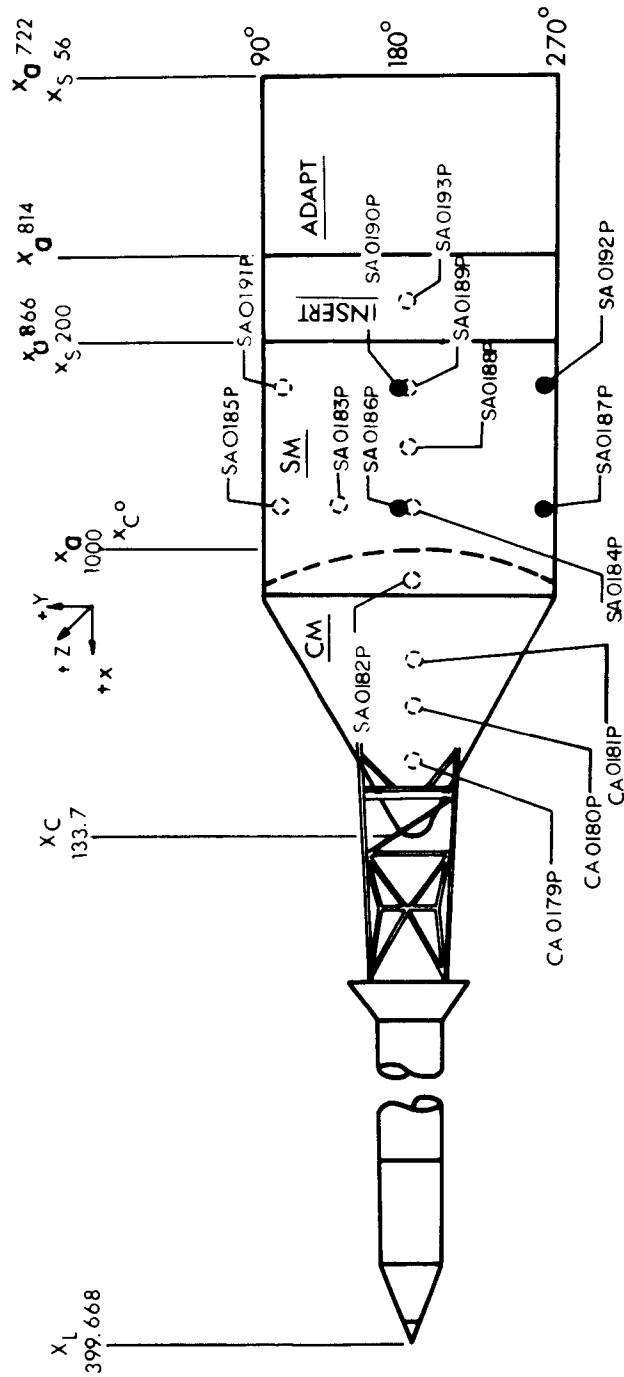


(b)-Calorimeter and calorimeter body temperatures

Figure 7-2 Spacecraft Measurement Locations

- NOTES
- 1 THE MEASUREMENT LOCATIONS ARE REFERENCED FROM THE +Z AXIS (+Z=0), AND THE MEASUREMENT ANGLE INCREASES AS THE MEASUREMENT LOCATION CHANGES PROGRESSIVELY FROM THE +Z AXIS TO THE +Y AXIS.
 - 2 SEE THE MEASUREMENT LISTS FOR SPECIFIC MEASUREMENT LOCATIONS.
 - 3 THE DIAGRAM IS NOT DRAWN TO SCALE.
 - 4 THE 20 CALORIMETER AND 20 CALORIMETER BODY TEMPERATURE MEASUREMENTS ARE SHOWN

7-28



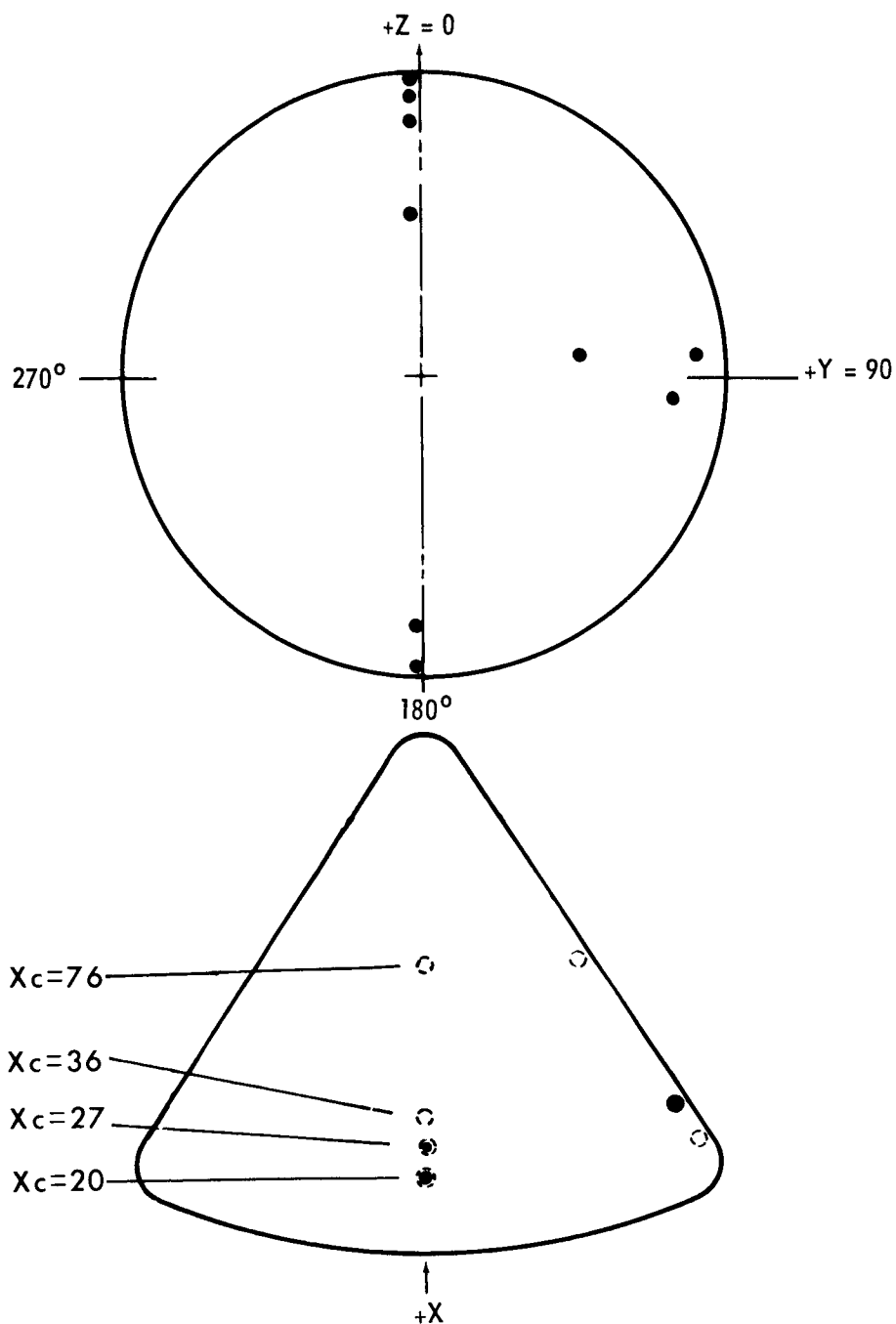
LEGEND

- EXPOSED
- HIDDEN

NOTES

- 1 THE MEASUREMENT LOCATIONS ARE REFERENCED FROM THE +Z AXIS (+Z=0°), AND THE MEASUREMENT ANGLE INCREASES AS THE MEASUREMENT LOCATION CHANGES PROGRESSIVELY FROM THE +Z AXIS TO THE +Y AXIS.
- 2 SEE THE MEASUREMENT LISTS FOR SPECIFIC MEASUREMENT LOCATIONS
- 3 THE DIAGRAM IS NOT SHOWN TO SCALE
- 4 THE 15 FLUCTUATING PRESSURE MEASUREMENTS ARE SHOWN.

(c) Fluctuating pressure transducers
Figure 7-2 Spacecraft Measurement Locations

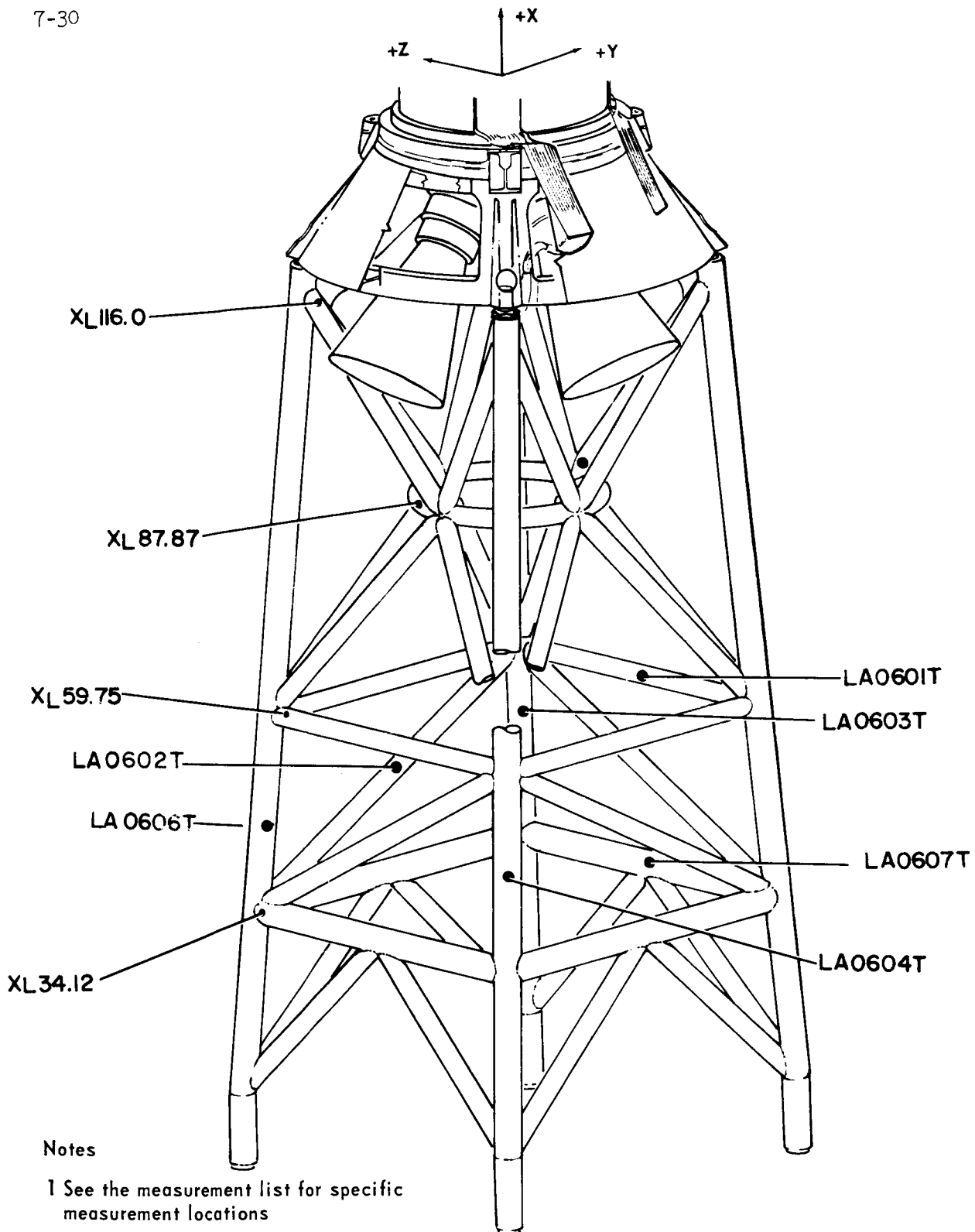


Notes

- 1 See the measurement lists for specific measurement locations
- 2 The diagrams are not drawn to scale

(d) Command Module static pressure locations
 Figure 7-2 Spacecraft Measurement Locations

7-30



(e) LES Tower temperature locations
 Figure 7-2 Spacecraft Measurement locations

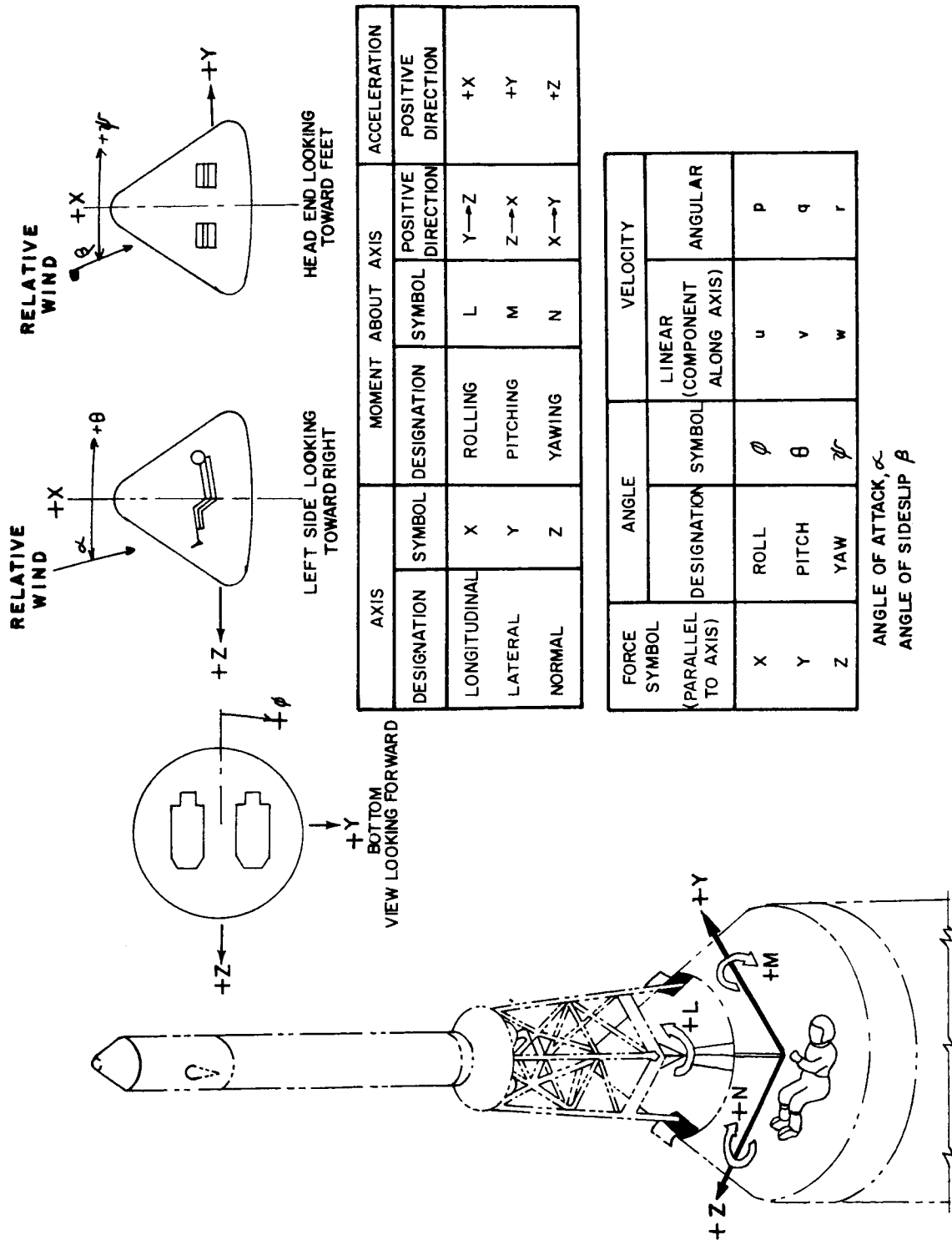


FIGURE 7-3 REFERENCE AXIS SYSTEM

8.0 TRACKING AND SUPPORT DATA REQUIREMENTS

8.1 General.-

Detailed tracking and support data requirements are included in the AMR Operations Requirements No. 2400. The requirements include parameters, coverage intervals, accuracies, and range contractor data disposition. This section will briefly outline the types of coverages to be provided by AMR. The following types of data will be made available to the Ad Hoc reporting team for BP-13.

8.2 Metric Trajectory Data.-

Metric trajectory data on the spacecraft are required from launch through orbit insertion and the first orbital pass over AMR. Since no single tracking station will be able to provide the necessary data coverage throughout the entire trajectory, it will be necessary to implement three different types of data acquisition systems. These systems include fixed optical, tracking cinetheodolite optical, and electronic tracking systems. The data coverage intervals, quantity and quality are specified in the AMR Operations Requirements No. 2400.

8.3 Photographic Data.-

8.3.1 Documentary Photographic Coverage.-

A complete motion picture and still photography documentary record of all key events associated with the test is required. The detailed documentary photo requirements will be prepared and submitted to the AMR on standard AFMTC Form 66. The following activities will be covered.

- a. Transportation
- b. Pre-Flight Preparations and Checkout
- c. Flight Operations
- d. Post-Flight Activity and Events

8.3.2 Engineering Sequential Photographic Coverage.-

Visible events data coverage from launch through the mid-course phase of the trajectory is required. This events coverage will be provided by engineering sequential optical systems as follows:

a. Fixed motion picture coverage

- (1) Pre-launch phase - A continuous emergency surveillance from T-2 hr. to T + 5 sec.
- (2) Launch phase - Lift-off coverage and structural surveillance of Apollo systems interface areas.

b. Tracking motion picture coverage

- (1) Launch phase - S-I staging, S-IV ignition, escape tower separation, and S-IV cutoff.

8.4 Timing.-

Time codes within accuracy of one millisecond (0.001 sec.) are required for data recording and correlation. Timing codes appropriate to the recording speed type and data usage are specified in the Operations Requirements No. 2400. A common time reference will be used for correlation of data from all data acquisition systems. All time distribution equipments will be furnished by the AMR at all test sites.

8.5 Meteorological Data.-

The only spacecraft meteorological data required are the surface and upper air conditions at launch. These data are required for post-flight data analysis as specified in the Operations Requirements (OR) document.

8.6 Data Disposition.-

- 8.6.1 Trajectory data in tabular form and in the BCD format on magnetic tape are required within 3 working days after launch.
- 8.6.2 Engineering sequential film copies and events times are required within 24 hours after launch.
- 8.6.3 Final meteorological data of launch conditions are required within 24 hours after launch.
- 8.6.4 Trajectory data in tabulated form (quick-look) will be required within 2 calendar days after launch.

9.0 PRELAUNCH OPERATION

9.1 Test Preparation - NAA, Downey.-

The initial spacecraft test sequence was accomplished in the spacecraft test preparation area at NAA, Downey facility, prior to shipping the boilerplate to AMR.

The undersupport condition of GSE for Boilerplate No. 13 necessitated an alternate method for accomplishing individual subsystems checkout in Apollo Test and Operations (AT&O) at Downey. To ensure adequate equipment for checkout in lieu of GSE, the Special Adaptive Devices (SAD) program was implemented. The primary function of "SAD" is to adapt the Manufacturing checkout equipment and Systems Measuring Devices (SMD), including cable assemblies, to accomplish individual subsystems checkout operations as programmed for Test Preparation - NAA, Downey.

As GSE was received in the Test Preparation area in Downey, a parallel verification program was conducted to ensure the operational characteristics of the GSE. The available items of GSE were installed in the test tower adjacent to the Test Preparation area and utilized for the integrated subsystems testing.

The sequence of test operations consisted of the following plus the parallel GSE verification as described above.

9.1.1 Spacecraft and SMD/GSE Preparation.-

Test Preparation at Downey received the boilerplate from manufacturing final assembly and processed it through the sequence shown in Figure 9-1. A complete examination of the SMD/GSE and boilerplate systems and subsystems was performed to ensure conformance with the latest configuration, specifications, and engineering orders to ensure readiness of the hardware for test operations.

The necessary modifications and updating of the boilerplate and SMD/GSE to the latest engineering orders were completed. The SMD/GSE was validated and SMD/GSE to spacecraft compatibility was checked.

9.1.2 Individual Subsystems Tests.-

The various interconnecting cables and lines were installed and the individual subsystem tests were performed using NASA approved Operational Test Procedures. These tests were performed to ensure the functional operation of the subsystems and to verify individual subsystem performance within engineering specification. Subsystems checkout include power distribution, environmental control, electrical, telemetry and beacon antennas, C-Band beacon, telemetry, instrumentation, RFI, and LES sequencer.

9.1.3 Modification and Updating.-

Prior to the integrated subsystems test the necessary modifications and updating of the flight hardware and GSE were accomplished and checked out. The adapter/insert service module and command module were weighed for c. g. determination. Upon receipt of late arriving GSE, each item was compared with the SMD function, validated, spacecraft compatibility checked, and prepared for a GSE integrated test.

9.1.4 Integrated Subsystems Test.-

The integrated subsystems test was performed in a test tower adjacent to the Test Preparation area. The spacecraft modules were mechanically and electrically mated in the launch configuration and properly aligned with the launch vehicle simulated. This test was conducted to ensure satisfactory subsystem interactions and non-interference. The tests included a mission simulation through orbit insertion, with umbilical disconnected to demonstrate functional compatibility of the systems before shipment to the field site.

9.1.5 Preparation for Shipment.-

The spacecraft modules were demated, the Environmental Control Subsystem was drained and purged, and the modules cleaned, examined, and closed out. Final paint touch-up and preparation for shipment were completed on the spacecraft and GSE. Downey operations on this boilerplate terminate with air shipment of the spacecraft and GSE to AMR.

9.1.6 B/P-13 Test Preparation Procedures Downey.-

<u>OTP NO.</u>	<u>TITLE</u>
	<u>Integrated Procedures</u>
0003	Integrated Sys. C/O with Simulator
	<u>Electrical Subsystems</u>
1012	Battery Servicing
1048	Elec. Power Sys. Checkout Using SMD
	<u>LES</u>
1047	LES Checkout Using SMD
2014	LES/ET Disassembly
	<u>Structures & Mechanical Subsystems</u>
3004	Preparation for Receiving Inspection
3013	Mate & Demate ET/CM
3014	Mate & Demate C/M - S/M
3015	Mate & Demate S/M - S/M Extension
3016	Mate & Demate S/M Extension - S/C Adapter
3018	Mate & Demate C/M Fwd. Heat Shield
3020	S/M Weight & C. G Determination
3021	S/C - S/M Extension Weight and C. G. Determination
3028	C/M Weight & C. G., Horizontal and Vertical
3029	C/M - LES Alignment & Weight & C. G. Vertical
3034	C/M Weight Fixture Assy. Instl. & Alignment
	<u>Environmental Control Subsystem</u>
5022	ECS Checkout using SMD
	<u>Instrumentation & Communications Subsystems</u>
8023	Airborne Telemetry Antenna Checkout
8071	Radar Transponder Antenna Checkout
8101	Pressure Transducer C/O Using SMD
8102	T/M System C/O Using SMD
8103	RF System C/O Using SMD
8104	Temperature Transducer C/O Using SMD
8105	Vibration Transducer C/O
8107	Strain Gage C/O Using SMD
8108	Accelerometer C/O Using SMD

OTP NO.Ground Support Equipment

9002	LES Substitute Unit Validation
9003	Pyro Substitute Unit Validation
9004	S/C Ground Power Console Checkout
9005	L/V Simulator Unit Validation
9006	Auxiliary Crane Control C/O
9007	Test Conductor Console C/O
9008	Cable Continuity C/O
9009	LES BME Validation
9011	LES Console Validation
9012	Inst. & Comm. Console Validation
9013	RF Checkout Unit Validation
9014	Signal Conditioner Console Validation
9015	ECS Console Validation
9016	Battery Charger Checkout
9017	Water Glycol Cooling Unit Checkout
9019	GSE Integrated Checkout - Hangar
9022	Procedure for Data Recording Grp. Func. Verif.
9032	Umbilical C/O & Hookup - Hangar
9034	Electrical Term. Distributor Validation
9035	Umbilical Junction Box Validation
9039	D. C. Power Supply Validation
9104	MSFC Patch & Logic Distr. Sub Unit No. 1 Validation
9105	S/C GSE Crossover Distributor Validation
10002	Test Configuration Checklist
9102	SMD Integrated Checkout
9103	SMD Water Glycol Cooling Unit C/O
10003	Test Configuration Using SMD

9.2 AMR Operations.-

Checkout Operations at the AMR are outlined in OTP-C-20,000-BP 13, BP-13 Operations Plan (Ref. 6). This plan encompasses the operations schedule from early arriving GSE through post-countdown securing. The following is a brief description of the AMR checkout of boilerplate 13.

9.2.1 Hangar AF.-

Ground cooling will be required for all tests discussed in Paragraphs 9.2.1.6, 9.2.1.7, and 9.2.1.8 to maintain an acceptable equipment temperature. All tests will use detailed Operational Test Procedures (OTP's) designed to penetrate to the black box level.

9.2.1.1 GSE.-

Upon arrival at AMR, the GSE will be transported from the aircraft to the Hangar where the items will be positioned and undergo receiving inspection. Cable continuity will be checked; proper operation of consoles, terminal boxes, simulators, etc. will be verified and a Facility-GSE integrated test will be performed in the Hangar AF Facility. Many items of GSE (those not required for handling the vehicle following Integrated Systems Test at Downey) will be shipped early in order to have a minimum schedule impact on AMR operations.

9.2.1.2 Boilerplate.-

Upon arrival of the boilerplate at AMR, the modules will be transported to Hangar AF and positioned for receiving inspection. Access hatches will be removed and inspection accomplished. Component part numbers and serial numbers will be compared with the documented configuration. A review of all existing design paperwork will determine any updating required. An Escape Tower fit check will be accomplished.

9.2.1.3 LES.-

LES buildup and weight and balance activity will be performed as a parallel effort after the necessary receiving inspection and during the initial test preparation period. The Launch Escape System will be electrically mated and a complete sequential system checkout accomplished.

9.2.1.4 Environmental Control Subsystem.-

The Environmental Control Subsystem will be proof checked at a pressure of 75 psig. Proper pump rotation will be verified. The thermostatches, valves, pumps, and fan will be functionally checked. A subsystem fill and bleed will be performed using a 40% water - 60% glycol (by volume) solution. The complete subsystem will be operationally checked and prepared for support of telemetry checks.

9.2.1.5 Electrical Power Subsystem.-

"Power off" checks will be performed on the power distribution subsystem, followed by "Power on" checks. A sequential subsystem test will be performed using the Launch Vehicle Simulator.

9.2.1.6 Instrumentation.-

An on-board instrumentation check will be performed to verify that all measurements are operating and responding properly to stimuli.

9.2.1.7 Ground Communications.-

Telemetry checkout will be made. This will verify proper frequencies, power output levels, calibration, and tuning. Power system tests will include monitoring load current under simulated operating conditions for a specific length of time to verify the capability of the batteries.

9.2.1.8 Modifications.-

A modification period will follow the individual subsystems functional and operational checks. The vehicle and GSE will be updated to flight configuration. Proper subsystem operation will be re-established as required. The air barrier will be installed in the adapter per appropriate procedure.

9.2.1.9 Integrated Subsystems.-

The command module, service module, and insert/adapter assembly will be mechanically and electrically mated and spacecraft alignment verified. The Launch Escape Subsystem will be electrically mated to the spacecraft.

An antenna checkout will be performed followed by C-Band transponder checkout. Integrated subsystems tests will include simulated countdown and flight. The Launch Escape Subsystem will be electrically demated. The mated spacecraft less the LES will be transported as a unit to Launch Complex 37B. GSE will be disconnected and transported to the launch complex.

9.2.2 Launch Complex 37B

- 9.2.2.1 Launch complex operations will be geared to the launch vehicle checkout schedule. GSE peculiar to the launch complex will have been installed and checkout accomplished during vehicle operations in the hangar. Remaining GSE will be functionally checked and a Facility-GSE integrated system test accomplished. The spacecraft will be mated to the launch vehicle. The LES will be mated to the spacecraft. MSFC will check and correct Q -ball alignment as required.
- 9.2.2.2 GSE will be connected and interfaces verified. Environmental Control subsystem will be serviced and final subsystems verification will be made. Ground tests of telemetry and radar beacons will include frequencies, power output levels, calibration, and tuning. Electrical Power Subsystem checks will include monitoring the electrical and instrumentation battery subsystem voltage and current.
- 9.2.2.3 Sequential subsystem verification will require the installation of pyrotechnic simulators which will be connected to the event recorder. Checkout will include exercising the pyro arm-safe relay, activating the sequencer, recording the sequenced operation, and monitoring the pyro batteries during sequencer operation. The simulators will verify adequate firing energy and monitor for inadvertent transients. A telemetry recording of these events will be made to verify proper LES instrumentation operation.
- 9.2.2.4 Several overall tests (OAT's) will be performed in conjunction with the launch vehicle. Integrated subsystems tests will be accomplished to verify proper system performance with umbilicals in, umbilicals out, maximum GSE and minimum GSE. Emergency procedures will be verified. RF compatibility checks will be made with all spacecraft and launch vehicle subsystems radiating open loop. This test will be performed with the Service Structure in place and again with the Service Structure removed. At least one simulated flight

will be made using live ordnance, which will be fired into suitable test chambers to determine actual transients in the system.

9.2.3 Launch Day Activities.-

By the start of countdown, Boilerplate 13 will have been mated to the launch vehicle, Q-ball alignment verified, and final systems verification completed. Overall compatibility with the launch vehicle and the range will be verified. Live ordnance will be installed with pyrotechnics shorted, checkout with flight batteries, and shorting devices unloaded.

9.2.4 BP-13 Test Preparation Procedures AMR. -OTPTITLEIntegrated

C-0003 Integrated Subsystems C/O with Simulator-Hangar
C-0004 Integrated Subsystems C/O No. 1
C-0005 Final Subsystems Verification - Pad
C-0006 Precount
C-0007 Countdown
C-0009 Integrated Subsystems C/O No. 2
C-0021 Post Countdown Securing
C-0028 Integrated Subsystems C/O No. 3
C-0029 Simulated Flight

Electrical Power Subsystem

C-1008 EPS C/O Electrical Power Subsystem
C-1050 Sequential Subsystems C/O
C-1051 Power & Sequential PIA Procedure

Structures

C-3028 CM Horizontal and Vertical Weight and C. G. Determination
C-3043 SM and SC Adapter Weight and C. G. Determination
C-3045 LES Build-up Weight and C. G. Determination
C-3063 SC Receiving & Inspection
C-3065 SC Handling & Transportation to Launch Complex

Propulsion

C-4057 Rocket Motor Receiving, Inspection, Storage & Handling
C-4058 Pyro Receiving, Inspection, Storage & Handling

Environmental Control Subsystem

C-5000 ECS C/O
C-5020 ECS PIA Procedure

Instrumentation

C-8111 Instrumentation Functional C/O
C-8112 Instrumentation Subsystem PIA Procedure
C-8113 RF System Functional C/O
C-8114 Antenna VSWR Test
C-8115 RF System PIA Procedure
C-8129 Instrumentation Subsystem Bench C/O
C-8130 RF Compatibility Test

OTPTITLEGround Support Equipment

C-9002 LES Substitute Unit Validation
C-9003 Pyro Substitute Unit Validation
C-9109 GSE Handling & Transportation to Launch Complex
C-9005 L/V Simulator Unit Validation
C-9010 Pyro C/O Equipment Validation
C-9033 Umbilical C/O and Hookup - Pad
C-9036 Water Glycol Unit C/O - Pad
C-9037 GSE Integrated C/O - Pad
C-9038 Ground Cooling Cart C/O
C-9100 Cable Continuity C/O - Pad 34
C-9101 Cable Continuity C/O - Pad 37B
C-9106 GSE Receiving & Inspection
C-9107 Water Glycol - Complex C/O
C-9108 Complex Wiring C/O

Checklist

C-10000 Hangar AF Checklist

Sections

1-1 Auxiliary Crane Control Checkout
1-3 A14-001 Activation
1-4 A14-011 Deactivation
1-5 Mate S/M Insert to Adapter
1-6 Demate S/M Insert from Adapter
1-7 Mate S/M to S/M Insert
1-8 Demate S/M from S/M Insert
1-9 Mate C/M to S/M
1-10 Demate C/M from S/M
1-11 Mate Forward Heat Shield to C/M
1-12 Demate Forward Heat Shield from C/M
1-13 Mate ET to C/M - Inert
1-14 Demate ET from C/M - Inert
1-15 Mate ET to C/M - Explosive
1-16 Demate ET from C/M - Explosive
1-17 Facility C/O
2-0 Electrical Section
2-1 Battery Charger C/O
2-2 Battery Servicing
2-3 LES Harness Installation
2-4 Battery Installation (S/C)
2-5 Battery Removal (S/C)

OTPTITLEChecklist (Cont.)

C-10001 Pad Checklist

Section


- 1-1 Al4-O11 Activation
- 1-2 Al4-O11 Deactivation
- 1-3 Mate S/M Insert to Adapter
- 1-4 Demate S/M Insert from Adapter
- 1-5 Mate S/M to S/M Insert
- 1-6 Demate S/M from S/M Insert
- 1-7 Mate C/M to S/M
- 1-8 Demate C/M from S/M
- 1-9 Mate Forward Heat Shield to C/M
- 1-10 Demate Forward Heat Shield from C/M
- 1-11 Mate ET to C/M - Inert
- 1-12 Demate ET from C/M - Inert
- 1-13 Mate ET to C/M - Explosive
- 1-14 Demate ET from C/M - Explosive
- 1-15 Facility C/O
- 1-16 Mate ADP to the Instrument Unit
- 1-17 Demate ADP from the Instrument Unit
- 2-0 Electrical Section
- 2-1 Pyro C/O
- 2-2 Pyro Installation
- 2-3 Battery Instl (S/C)
- 2-4 Battery Removal (S/C)

9.3 Countdown Activities. -


This is a brief listing of the countdown activities as envisioned at this time. The official countdown will be written and coordinated at AMR.

<u>Hr/Min/Sec</u>	<u>Operation</u>	<u>Location</u>
T-6:00:00	1. Ordnance Crew only on pad 2. Check continuity, install tower separation and tower jettison motor initiators; (completed by T-5:40:00)	PAD S/C
T-5:20:00	1. Install conditioned solid propellant turbine spinners (completed by T-4:20:00)	S-I
T-4:10:00	1. Install Hypergol Cartridges (Completed by T-3:50:00)	S-I
T-3:40:00	1. Check continuity, install separation initiators and connect electrical plugs (Completed by T-3:50:00) 2. Check continuity, install spinner and destruct initiators and connect electrical plugs (Completed by T-3:10:00)	S-I S-I
T-3:10:00	1. Verify systems (Completed by T-2:40:00) a. ECS Pump Check b. TM Checks c. Power Transfer Check d. Beacon Checks e. Sequencer Check Connect LES & Sequencer Electrical Plugs.	S/C
T-3:05:00	1. Fill LO ₂ tank to 98% (Completed by T-2:40:00)	S-IV
T-2:46:00	1. Fill LO ₂ tank to 10% (Completed by T-2:25:00)	S-I

<u>Hr/Min/Sec</u>	<u>Operation</u>	<u>Location</u>
T-2:40:00	1. Replenish LO ₂ tank to 99-34% (Stop at T-0:20:20)	S-IV
	2. Close hatch (Complete by T-2:30:00)	S/C
T-2:30:00	1. Command Module Leak Check	
T-2:20:00	1. Remove Gantry (Complete by T-1:30:00)	PAD
T-1:30:00	1. Pad clear of personnel	
	2. Fill LO ₂ to 100%	S-I
T-1:00:00	1. Start LO ₂ Replenish	S-I
T-0:50:00	1. Start final fuel level correction (Complete by T-0:40:00)	S-I
T-0:45:00	1. Start Fuel Pressurization	S-I
T-0:40:00	1. Final Fuel Level Correct	S-I
	2. Start S/C Module GN Purge	S/C
	3. Start LH ₂ tanking to 95%	S-IV
T-0:35:00	1. Q Ball heater on	S/C
T-0:25:00	1. ECS Fan and Pump on	S/C
T-0:20:00	1. Instrumentation Buss, TM & Beacon On	S/C
T-0:05:20	1. Fuel tank pressurized	A-I
	2. LH ₂ tank filled	S-IV
	3. Engines gimballed and returned to Null	S-IV
	4. Replenish LH ₂ to 99%	S-IV
T-0:04:00	1. Power change over to internal, ECS to internal	S/C
	2. Pyro busses armed	S/C
T-0:03:30	1. ECS Ready Light on	S/C
	2. LES Ready Light on	S/C
T-0:02:50	1. TM Calibrate	S/C
T-0:02:31	1. Firing command	S-I



<u>Hr/Min/Sec</u>	<u>Operation</u>	<u>Location</u>
T-0:02:30	1. Power Transfer	S-IV
	2. Start LO ₂ pressurization	S-IV
	3. Start LO ₂ bubbling	S-I
T-0:02:20	1. RF Ready Light on	S/C
T-0:02:10	1. Start LH ₂ replenishing to 100%	S-IV
T-0:02:00	1. S/C ready light on	S/C
T-0:01:28	1. LO ₂ bubbling off	S-I
	2. Start LO ₂ pressurization	S-I
T-0:00:55	1. Start S-IV Calibration	S-IV
	2. LO ₂ pressurization complete	S-IV
	3. LO ₂ replenishing complete	S-IV
	4. LH ₂ replenishing complete	S-IV
T-0:00:45	1. S-IV Calibration Complete	S-I
T-0:00:15	1. Module GN ₂ purge off	S/C
	2. Umbilical Disconnect	S/C
T-0:00:05	1. LO ₂ pressurization complete	S-I
	2. Power transfer complete	S-I
T-0:00:00	1. Ignition command	S-I
T+0:00:01	1. Engine Start	
T+0:00:03:42	1. Hold down Release	S-I
	2. Lift off	



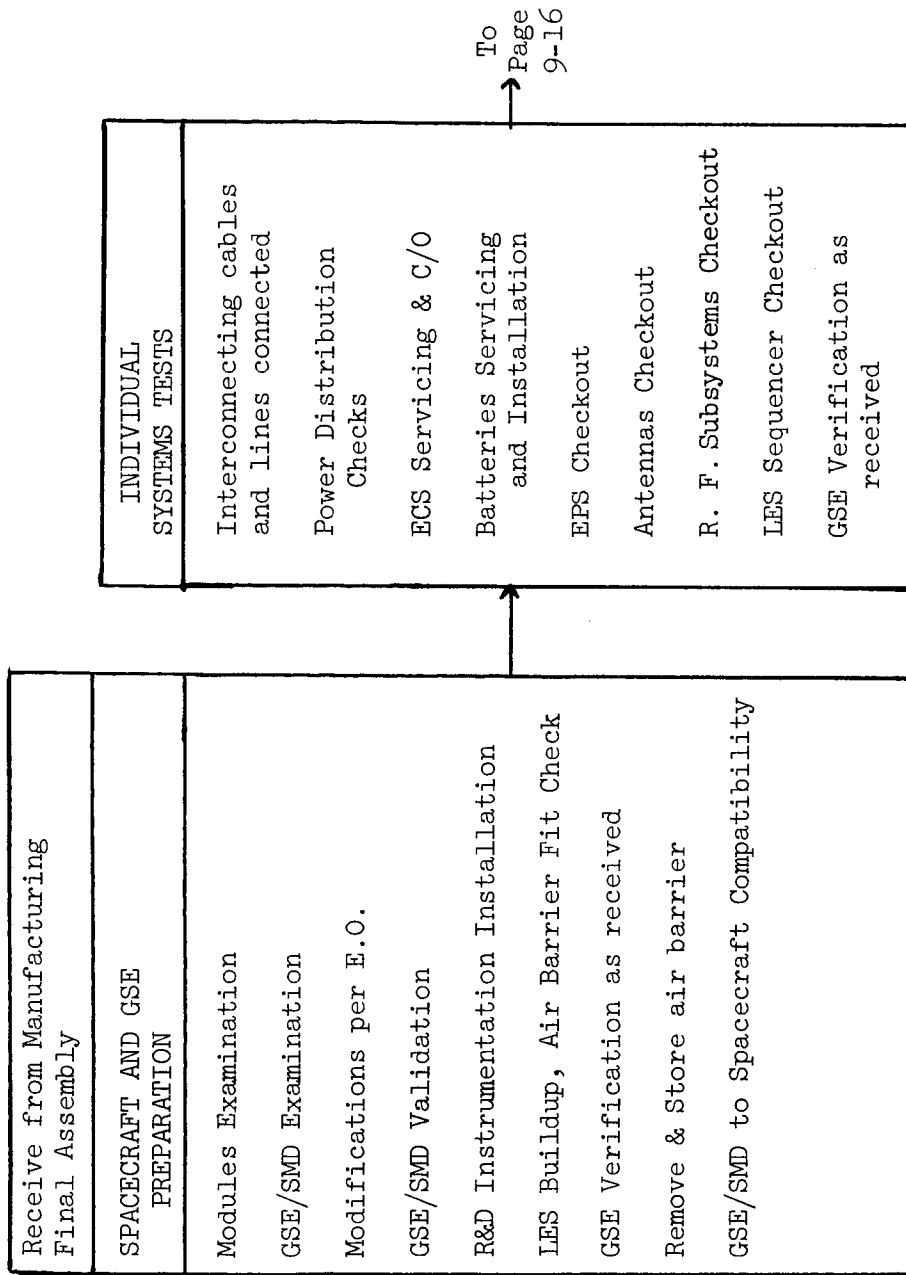


Figure 9-1 Sequence of Test Operations

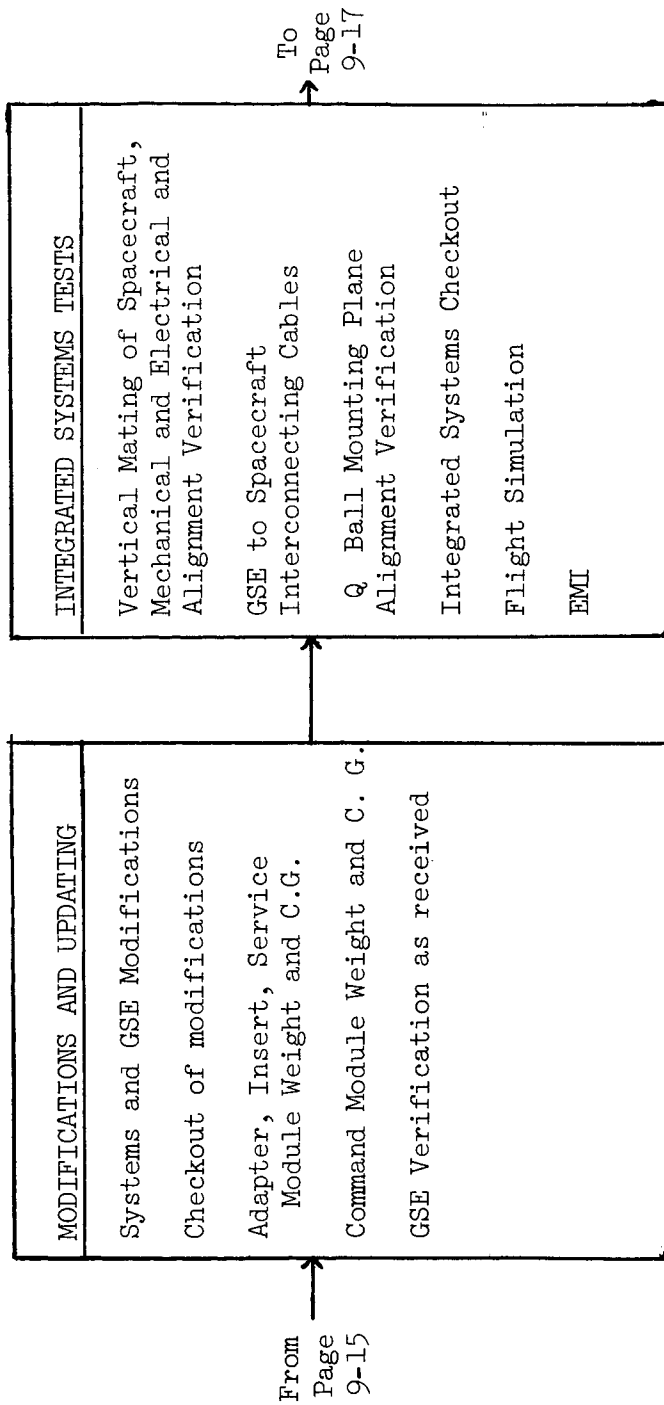


Figure 9-1. Sequence of Test Operations

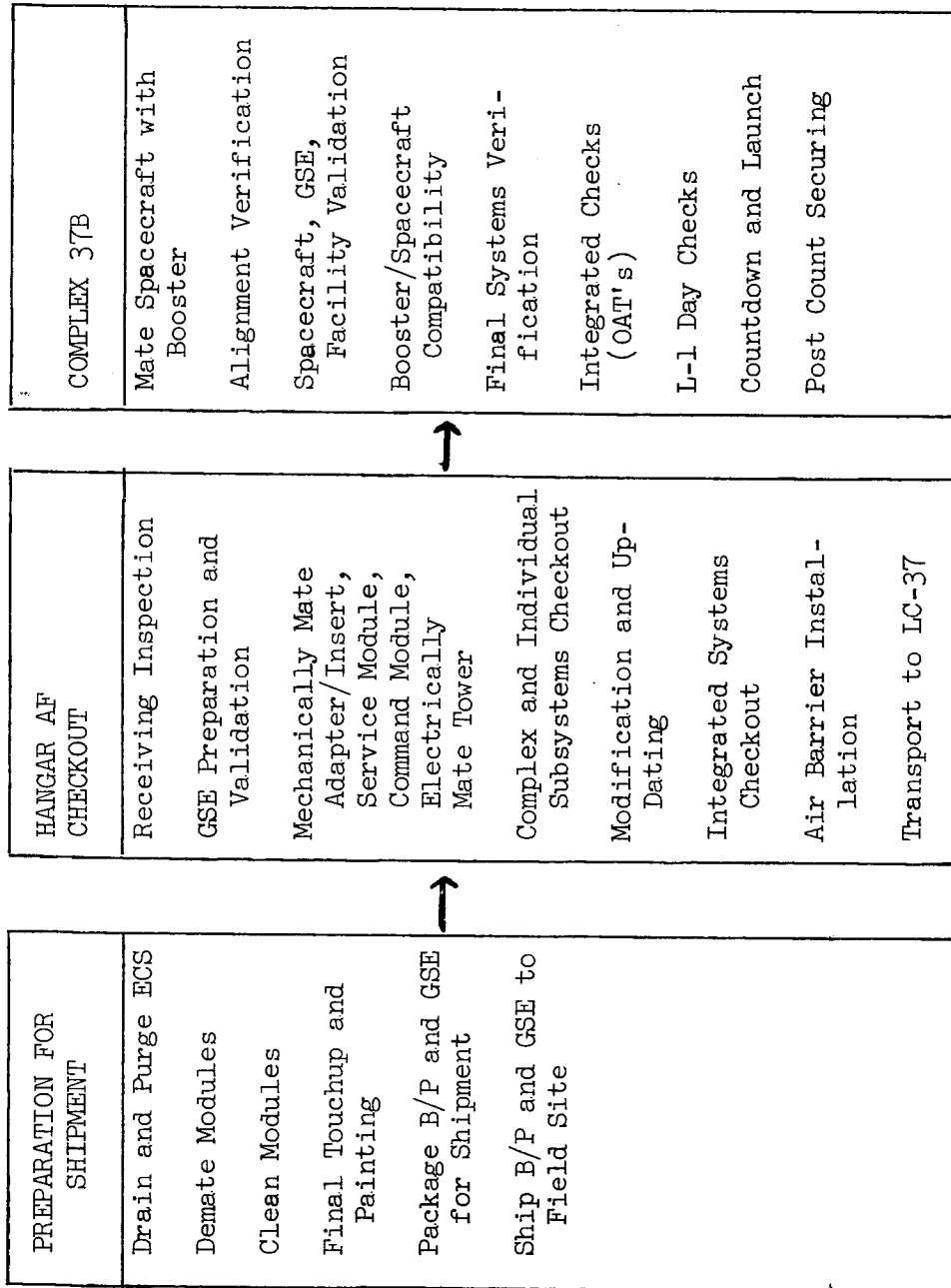


Figure 9-1. Sequence of Test Operations

10.0 TEST MANAGEMENT ORGANIZATION

10.1 General.-

The Test Management Organization will be supplied at a later date.

11.0 RECOVERY REQUIREMENTS

11.1 General. -

There are no recovery requirements for boilerplate 13.

12.0 LAUNCH DAY REQUIREMENTS

12.1 Weather Requirements for Launch. -

The weather requirements for launch of boilerplate 13 will be dictated by launch vehicle restrictions. Ref. 3 details the restraints.

13.0 PAD AND RANGE SAFETY REQUIREMENTS

13.1 Pad Safety. -

All provisions of the "General Range Safety Plan, Volume I", AFMTC Pamphlet No. 80-2 (Ref. 12), are applicable unless specifically excepted, modified or supplemented.

13.2 Range Safety. -

Range safety requirements shall be in accordance with the "General Range Safety Plan, Volume II," AFMTC Pamphlet No. 80-2 (Ref 12). This document supplements the general safety policies and procedures prescribed in AFMTC Regulation 80-9.

14.0 DATA HANDLING, ANALYSIS AND REPORTING

14.1 Data Handling.-14.1.1 General.-

Launch site data handling activities will be responsibility of the MSC Operations Support Office (OSO) under the direction of MSC-ASPO.

- a. Receive and coordinate all requests for mission data, as specified by ASPO.
- b. Coordinate ASPO requirements with the various facilities of the Kennedy Space Center and the AMR.
- c. Log and distribute records, tapes, listings, etc., as required, to the various NASA and contractor organizations.
- d. Support post launch analysis and reporting efforts by providing data support as specified by ASPO and providing facilities and equipment required.

14.1.2 Mission Data Support Documentation.-

Overall data requirements for Range Support are presented in the Saturn I Program Requirements Document Number 2400, and in more detail in a mission Data Acquisition Plan. The Program Requirements Document levies broad tracking, receiving, and recording requirements on the Range and the Data Acquisition Plan will specify detailed real time recorder setups and displays at the various mission support facilities. In addition, the Data Acquisition Plan will provide specific information on data which will be available for evaluation and analysis. The above documents will be prepared by the MSC Operations Support Office from requirements received from the ASPO and Operations Division.

14.1.3 Launch Site Data Coordination.-

The MSC data activities at the launch site and on the range will be coordinated by MSC-OSO. The ASPO-Test Evaluation Branch will coordinate those activities concerned with data produced at MSC-Houston and NAA-Downey.

14.2 Mission Analysis and Reporting.-

The ASPO Test Division will have overall responsibility for Mission Analysis and Reporting. Contributions to this effort will be required from both NAA and from organizational elements of MSC located at the launch site and in Houston, Texas. A reporting plan will be prepared by the ASPO Test Division prior to the mission which will outline the analysis procedures and report format and will designate the Ad Hoc reporting team which will be charged with the responsibility for implementing the plan. It is presently planned that the mission results will be reported as follows:

14.2.1 One Hour Report.-

The T+1 hour report will be in the form of a TWX and will simply be a notification that the test was completed, approximate test duration, and pertinent comments.

14.2.2 Flight Status Report.-

This is a preliminary analysis report published in the form of a TWX approximately 24 hours after flight. This report will be based on quick-look data. It will be written by MSC/ASPO and NAA personnel at the site under the direction of MSC/ASPO, and forwarded to MSC and NAA personnel at the site under the direction of MSC/ASPO, and forwarded to MSC and NAA managements. Additional Flight Status Reports will be written at 24 hour intervals if required.

14.2.3 Post Launch Report.-

This report will be prepared at the site as a joint effort between NASA-MSC/Florida Operations, MSC-Houston, and NAA personnel under the direction of MSC-ASPO. It will be based on the analysis of plotted flight data plus range instrumentation data and will be issued by NASA-MSC/ASPO, Houston, 18 calendar days after launch.

14.2.4 Contractor Spacecraft Analysis Report.-

This report will contain the full spacecraft analysis and will be issued 30 days after launch by NAA-Downey to MSC/ASPO for further disposition.

15.0 GROUND SUPPORT EQUIPMENT

15.1 General. -

GSE will be assigned to BP-13 at Downey and will remain with the vehicle through launch operations. After launch, the GSE will be re-assigned, according to the GSE Planning and Requirements.

GSE will be evaluated with regard to operational suitability. Operational Test Procedures, Quality Control, and Reliability Records will be used to make the evaluation.

Four general groups of GSE will be utilized in the various areas of Checkout and Testing:

- (C) Checkout Equipment (i.e., systems control and monitoring devices, interconnecting cables, and power distribution systems), C14-XXX.
- (H) Handling Equipment (i.e., slings, dollies, supports, etc.) H14-XXX.
- (A) Auxiliary Equipment (i.e., protective covers, dummy motors, simulators, etc.), A14-XXX.
- (S) Servicing Equipment (i.e., battery chargers, fluid transfer and booster units, etc.), S14-XXX.

15.2 Ground Support Equipment. -

<u>Number</u>	<u>Title</u>
A14-001	Launch Escape System Substitute Unit
A14-003	Pyrotechnic Initiators Substitute Unit
A14-009	Spacecraft Adapter Cover
A14-010	Command Module Cover
A14-011	Command Module Ground Cooling Cart
A14-020	Service Module Cover
A14-021	Launch Vehicle Substitute Unit, C-1

<u>Number</u>	<u>Title</u>
A14-022	LES Cover
A14-024	Umbilical Disconnect Set (Fluid & Elect)
A14-026	Cap and Plug Set
A14-027	Adapter Cap and Plug Set
A14-028	Optical Alignment Set
A14-035	Vacuum Cleaner
A14-036	Ground Air Circulating Unit
A14-037	Adapter and Duct Set
A14-038	Launch Escape Motor, Dummy
A14-039	Tower Jettison Motor, Dummy
A14-040	Pitch Control Motor, Dummy
A14-046	Control Crane, Auxiliary
A14-047	Box Level
A14-075	MSFC Patch & Logic Distributor Substitute Unit #1
A14-076	MSFC Patch & Logic Distributor Substitute Unit #2
A14-130	Wrench Set - Explosive Bolts
*C14-021	Telemetry Ground Station
C14-029	LES Sequencer Bench Maintenance Equipment
*C14-032	Antenna Checkout Group
C14-051	Pyrotechnics Bench Maintenance Equipment
*C14-112	Radar Transponder and Recovery Beacon Checkout Unit
C14-135	Signal Conditioner Console

* These units will be furnished by MSC as GFP.

<u>Number</u>	<u>Title</u>
C14-177	Cable Set, Electrical, Pad 37B
C14-180	Electrical Cable Set (AMR Pad 34)
C14-186	Cable Set, Electrical, Test Prep.
C14-191	Electrical Terminal Distributor
C14-192	Umbilical Junction Box
C14-414	Test Conductors Group
C14-418	28 VDC Power Supply and Switching Unit
C14-420	Data Distribution and Recording Console
C14-458	Static EMI Checkout Device
C14-461	Breakout Box Set, EMI Test
C14-481	DC Ground Power Distribution Panel
H14-9001	Command Module Sling
H14-9006	Sling Set - Weight and c.g. - C/M
H14-011	Launch Escape Alignment Stand (2 units)
H14-9015	Jack Set, Weight and Balance, C/M
H14-016	LES Weight and Balance Fixture
H14-017	Weight and Balance Fixture
H14-018	Escape Tower Support
H14-021	GSE Handling Cart
H14-027	Adapter, Rail Transfer, LES Skirt
H14-029	Sling, Flow Skirt
H14-9030	Base Support, S/M and Adapter
H14-9056	Heat Shield Sling

<u>Number</u>	<u>Title</u>
H14-030	Spacecraft Support Base
H14-040	Electronic Weighing Kit (3000# Capability)
H14-041	Electronic Weighing Kit (30,000# Capability)
H14-042	Hoist Beam, Service Module and Adapter
H14-043	Jettison Motor Sling
H14-052	Positioning Trailer, Narrow Base
H14-054	Jettison Motor Support
H14-055	Launch Escape Motor Support
H14-057	Forward Compartment Shield Sling
H14-9059	S/M and Adapter Weight and c.g. Fixture
H14-9073	S/C Boilerplate Sling (without LES)
H14-9076	General Purpose Dolly
H14-9077	Sling, Access Door, S/M
H14-074	SC with LES Sling
H14-083	Cradle, LES Transport
H14-084	Adapter Roll Over
H14-085	Sling, Horizontal Handling, LES Motor
H14-086	Support Base Assembly - Tubular, Boilerplate
H14-090	Stand, C/M Recovery Area Access
H14-091	Stand, C/M Hatch Access
H14-092	Sling, Pitch Control Motor Interstage Structure
H14-093	Boatswain's Chair

<u>Number</u>	<u>Title</u>
H14-094	Sling, Jettison and Pitch Control Motor, Nose Cone
H14-096	Hook, LES Ballast Pickup
H14-097	Stand, LES Buildup Access (w units)
H14-099	Wrench, Pitch Control Motor
H14-101	Access Platform (3' - 10')
H14-109	S/M External Access Stand
H14-111	Access Stairs, C/M Hatch
H14-126	Beam, Weight and Balance, S/M and Adapter
H14-127	Cable and Fitting Set, Weight and Balance, S/M and Adapter
H14-131	Spacecraft Vertical Transport Vehicle
H14-139	Forward Compartment Heat Shield Retention Bolt Guide
H14-145	Shipping Container Sling
H14-146	Cartridge Assembly Boatswain's Chair Trolley
H14-147	Service Module Internal Work Platform
H14-154	DC Electronic Weighing Kit
H14-156	LET Horizontal Sling
S14-015	Battery Charging Unit
S14-034	Fluid Distribution System (Downey)
S14-036	Fluid Distribution System (Hangar AF)
S14-052	Water Glycol Cooling Unit
S14-078	Mobile Pressure Leak Test, LES Motor

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<u>Number</u>	<u>Title</u>
S14-081	Fluid Distribution System (Downey Tower)
GFP C021	Telemetry Ground Station
GFP C032	Antenna Checkout Group
GFP C112	Radar Transponder and Recovery Beacon Checkout Unit
GFP H101	Access Platform (3' - 10')

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16.0 REFERENCES

1. "Apollo Spacecraft Requirement Specification", SID 62-700-2, Published by North American Aviation, Space and Information Systems Division. (Confidential)
2. "Weight, Balance and Inertia of the Apollo Boilerplate Configurations, SID 62-1434. Published by North American Aviation, Space and Information Systems Division. (Confidential)
3. "Operations Requirements No. 2400". Published by National Aeronautics and Space Administration. (Confidential)
4. "Apollo Integrated Systems GSE Operational Concept for Boilerplate 13", SID-62-1455. Published by North American Aviation, Space and Information Systems Division. (Unclassified)
5. "General Test Plan, Research and Development for Project Apollo Spacecraft, Volume V, Multiple Systems Tests", SID 62-109-1. Published by North American Aviation, Space and Information Systems Division. (Confidential)
6. Operational Test Procedure, C 20,000 - B/P 13 (Unclassified)
7. Apollo Test Requirements ATR-500 (Unclassified)
8. Apollo Test Requirements ATR-102B (Unclassified)
9. Test Specification MA 0205-0014 (Unclassified)
10. Test Specification MA 0405-0002 (Unclassified)
11. Apollo Test Requirements ATR-2547 (Unclassified)
12. "General Range Safety Plan, Volume I," AFMTC Pamphlet #80-2. (Unclassified)
13. "Apollo Measurement Requirements, Boilerplate 13", SID 63-563. Published by North American Aviation, Space and Information Systems Division. (Confidential)

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